

AQUATIC AND WILDLIFE RESOURCES



DEPARTMENT OF AGRICULTURE

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AQUATIC & WILDLIFE RESOURCES DIVISION
Harry T. Kami, Chief

DEPARTMENT OF AGRICULTURE
Antonio S. Quitugua, Director

Edited By:
Robert D. Anderson
Michael E. Molina
Alan J. Hosmer

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AQUATIC & WILDLIFE RESOURCES STAFF

The following persons were on the staff of the Aquatic and Wildlife Resources Division sometime during the reporting period (October 1, 1981 to September 30, 1982):

Harry T. Kami, Chief
Robert D. Anderson, Assistant Chief

Sport Fisheries

Alan J. Hosmer, Fishery Biologist IV
R. Logan Kock, Jr., Fishery Biologist II
Michael E. Molina, Fishery Biologist II
Rob Myers, Fishery Biologist II
Christine Palomo, Fishery Biologist I

Aquaculture

Wayne Kruckenberg, Fishery Biologist II
Robert J. Cruz, Biological Aide

Commercial Fisheries

Deborah Grosenbaugh, Fisheries Planner/Program Coordinator

Wildlife

Anne Maben, Wildlife Biologist II
Gary J. Wiles, Wildlife Biologist II
Celestino F. Aguon, Wildlife Biologist I

Public Awareness/Conservation Education

Judy Beaver, Public Information Officer

Law Enforcement

Charles R. Bonds, Conservation Officer III
Johnny S. Villagomez, Conservation Officer II
Danny D. Wolford, Conservation II
Joseph M. Benavente, Conservation Officer I
Wayne Bigler, Conservation Officer I
David C. Torres, Conservation Officer I
David Q. Guerrero, Conservation Officer I (CZM)
Herman R. Quichocho, Conservation Officer I (CZM)

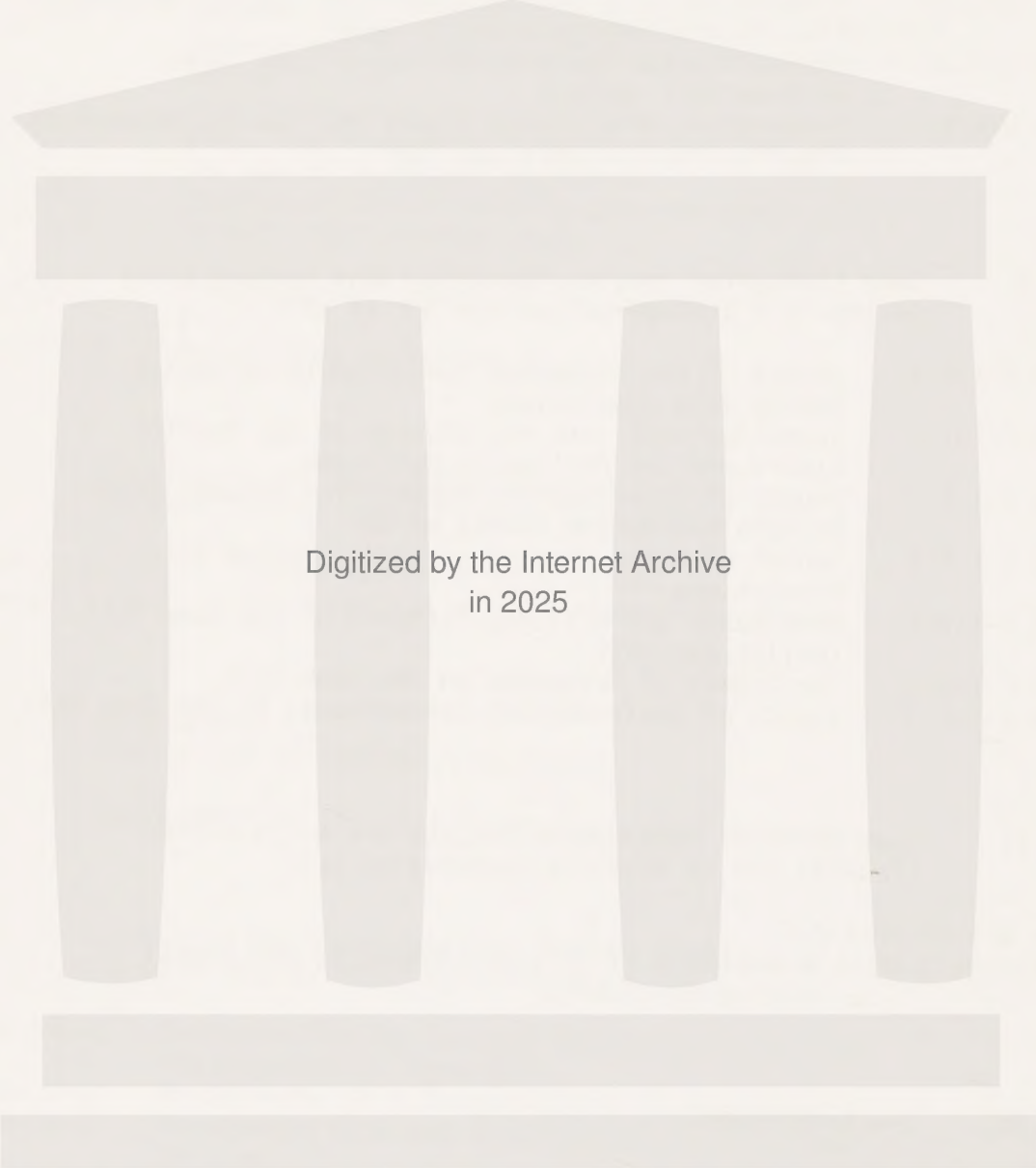
Clerical

Annie R. Bonds, Administrative Assistant
Janet C. Blas, Secretary Typist II
Guadalupe C. Mafnas, Clerk-Typist III
Nancy C. Mafnas, Clerk-Typist II

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GUAM FISHERIES INVESTIGATIONS
PROJECT FW-2R-19
Federal Aid in Sport Fish Restoration Act

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-19

SUB-PROJECT NO.: F

STUDY NO.: F-1

JOB NO.: 1

JOB TITLE: Offshore Creel Census

PERIOD COVERED: October 1, 1981 to September 30, 1982

SUMMARY

With a few exceptions, offshore fish landings were monitored for four days each month at the Agana Boat Basin and irregularly at Merizo Pier. In an effort to increase the collection of fishery and biological data without increasing time spent in the field, procedures used over the last several years were modified to concentrate sampling at times of heaviest returning boat traffic. The offshore fishing effort is divided among three primary methods: trolling, bottomfishing and spearfishing. Fishing methods of secondary importance are also included in the survey. Efforts have been initiated to adjust catch estimates of previous years in accordance with information not previously considered. Valid comparisons of year to year estimates will then be possible.

The total estimated catch for the three primary methods combined was 103.4 metric tons of fish landed at the Agana Boat Basin alone. Spin-casting and longlining accounted for an additional estimated 0.1 metric tons and shrimp trapping accounted for an estimated 0.4 metric tons. In addition, it is estimated that 14.6 metric tons were landed at Merizo Pier by trolling alone. It was not possible to estimate Merizo Pier bottomfishing or spearfishing landings, since no boats using these methods were censused. It is assumed that an average of 4 boats/day utilize other locations such as Apra Harbor, Ylig River, Agat or Umatac. Our best estimate for catches landed at these areas, based on this assumption is 26.8 metric tons for the three primary fishing methods combined. Combining the catch estimates for all areas and fishing methods results in an annual island-wide offshore harvest estimate of 144.8 metric tons. This represents a 17.2% increase over last year's estimate and is indicative of a trend towards increased fishing pressure directed at Guam's offshore species during the last few years.

BACKGROUND

Effective management of the island's offshore fishery resources requires accumulating data on fishing pressure, types of fishing methods and annual harvests. To this end, the Division of Aquatic & Wildlife Resources (DAWR) has been conducting offshore fishing interviews with offshore fishermen for more than five years.

OBJECTIVES

- I. To quantify fishing participation, effort and catch, which occurs outside the reef margin in boats.
- II. To collect biological data from specimens examined during interviews.

PROCEDURES

The FY 82 offshore creel census program was designed to increase the collection of biological data and the number of completed fisherman interviews obtained per unit time spent in the field. This required consideration of variables not utilized in previous years, such as weather and sea conditions and daily temporal trends in fishing activity.

As designed, two weekend/holiday and two weekday censuses were to be taken each month at the Agana Boat Basin. However, during the months of October, November, December, July, and September, only one weekday census was conducted, and during the months of December and January three weekend censuses were taken. Census dates are given in Table 1. Censuses were generally conducted between the hours of 1700 and 2100 to correspond with the bulk of daily returning fishing parties. Estimates of the number of fishing parties returning outside the census period were made in order to calculate their contribution to the total participation, effort and catch of each census day. This was done in a variety of ways including interviewing fishermen, personnel of the Fishermen's Cooperative, and residents living on boats berthed at the Agana Boat Basin. In addition parked trailers and empty berths were noted during non-censused hours of census days. The figure obtained was thus a conservative one, corresponding with the minimum known number of returning boats on a given day. Censuses were generally not conducted on days when few or no boats were expected or known to be fishing due to inclement weather. Low participation days were determined from a variety of sources, including personal observation by DAWR personnel, information from fishermen and the Fisherman's Cooperative, and weather records provided by the National Weather Service/Naval Oceanographic Command Detachment (NWS/NOCD).

Merizo Pier was censused on six days from October 1981 through January 1982. Thereafter, an attempt was made to obtain information through telephone interviews. This, however, proved unsuccessful. Limited personnel and logistic difficulties prevented the resumption of the Merizo Pier censuses for the remainder of FY 82.

Interview Procedures and Data Collection

1. Individuals from each returning fishing party were asked standard questions, to determine fishing methods, effort, participation, area fished, and effectiveness of offshore fish aggregating devices (FAD). Questions were prioritized, so the most important information was obtained for otherwise incomplete interviews. Attempts were made to intercept all boats returning, and to examine all catches. When this was impossible, the fisherman was asked to estimate the number of fish and total weight of his catch. Fishermen selling their catch to the Fishermen's Cooperative were given the lowest priority since their catch could usually be examined later and the

composition by numbers and weight could be obtained from the Cooperative's records. If time permitted, each fish was measured. If not, subsamples were taken and all unmeasured fishes of each species were counted. If additional data pairs were needed for a length-weight regression analysis of a given species it was also weighed. Batch weights of all measured, unweighed fishes were calculated by species from known length-weight relationships. Weights for species on which sufficient length-weight data were unavailable were determined by using data available for the most morphologically similar species.

Analysis

Weather records and surf reports supplied by NWS/NOCD, as well as personal observation of activities at the Agana Boat Basin indicate that 20 days during FY 82 were "unfishable" due to inclement weather. These were days in which no boats fished due to the closure of the Agana Boat Basin Channel by high surf, or when gale force winds were forecast. Of the remaining days, 101 were weekend days or holidays (WE/H) and 244 were weekdays (WD). Fifteen of the WE/H days and 46 of the WD days were considered "bad-weather" (D_w) days in which a limited amount of fishing took place. "Bad-weather" days were defined as those days in which a small craft warning was issued and not cancelled by 1400 hr, but which were otherwise fishable. All other days were considered normal, "good-weather" (D_g) days.

Missing data were calculated as follows: For a given interview in which the actual number of persons, lines or hours spent fishing is unknown, the mean for all other boats interviewed that day was used if at least three more were known, otherwise the monthly mean was used.

Sufficient sampling was conducted at the Agana Boat Basin to determine monthly trolling and bottomfishing catches. These were calculated by Method 1 outlined below. Since insufficient data were collected to determine monthly catches by other methods at the Agana Boat Basin or for any method at Merizo Pier an estimate of total annual catch was calculated by Method 2, for all methods at the Agana Boat Basin and for trolling at Merizo Pier. In cases where both methods were used for comparative purposes, Method 1 was considered the most reliable.

Method 1

For trolling and bottomfishing conducted at the Agana Boat Basin, catch estimates were determined on a monthly basis by the following formula:

$$E = \frac{B_f}{B_c} \times \frac{D_a - \left[D_1 + D_w \left(1 - \frac{b_w}{g_w} \right) \right]}{D_c} \times C$$

where: E = estimated monthly catch and is calculated separately for the collective weekend/holidays (designated as "we") and weekdays (designated as "wd") in a given month.

B_f = total no. of boats known to have fished on census days

Table 1. Days censused during FY 82 at the Agana Boat Basin and Merizo Pier. Numbers indicate the day of the month. Dg refers to "good-weather" days, Dw refers to fishable "bad-weather" days.

Month	Dates Censused at the Agana Boat Basin					Dates Censused at Merizo Pier				
	WE/H		WD		No. Days Per Mo.	WE/H		WD		No. Days Per Mo.
	<u>Dg</u>	<u>Dw</u>	<u>Dg</u>	<u>Dw</u>		<u>Dg</u>	<u>Dw</u>	<u>Dg</u>	<u>Dw</u>	
Oct.	24	12	21		3		12	22		2
Nov.	8,22		18		3	14		9		2
Dec.	19,27	26		9	4					
Jan.	10,16,23		7,20		5	31		27		2
Feb.	13,27		25,26		4					
Mar.	27	20	29	15	4					
Apr.	10,17		12,29		4					
May	8,29		27	11	4					
Jun	12,26		17	25	4					
Jul.	3,31		30		3					
Aug.	8,28		12,25		4					
Sep.	12,18		24		3					
	23	3	15	4	45	2	1	3	0	6

B_C = Total no. of boats censused.

D_a = No. of days available in a given month

D_1 = No. of days of no known fishing activity due to inclement weather

D_C = No. of days censused. If a census day is also a "Dw" day, (see below) it is multiplied by the ratio $\frac{bw}{gw}$.

D_W = No of days in which a small craft warning was issued and not cancelled by 1400 hr., in which boats were known to have been fishing. These days are generally characterized by the absence of severe weather affecting Guam, but by the predominance of gusty offshore winds exceeding 17 kts.

C = Censused catch

b_W = Mean No. of boats out on a Dw - designated day during FY 82.

g_W = Mean No. of boats out on a normal D_g designated day, during FY 82.

During FY 82, $\frac{bw}{gw}$ was $\frac{8.67}{13.26} = .654$ for weekends and holidays, collectively,

and $\frac{3.5}{7.0} = .500$ for weekdays, respectively (Table 2).

For example, during Oct, 1981:

For WE/H days, 14 out of 17 known boats fishing on census days were intercepted. Thus $\frac{B_f}{B_C} = 1.214$. Out of the 11 available WE/H in the month

there were no D_1 days, three D_W days, and two census days, one of which was a D_W

day. Thus, $\frac{D_a - [D_1 + D_W(\frac{bw}{1-gw})]}{D_C} = \frac{11 - [0 + 3(1 - .654)]}{1} = 6.023$. The

censused catch was 156.8 kg. The estimated WE/H catch is thus $1.214 \times 6.023 \times 156.8 = 1,146.5$ kg. The same procedure yields 1,726.1 kg for WD days giving a monthly catch estimated (E) of 2,872.6 kg.

For a given month and method, the estimated catch, E, equals the sum of the weekend/holiday catch (E_{we}) and the weekday catch (E_{wd}). Thus ΣE for one year is the estimated annual catch. The components B_f , B_C , D_1 , and D_W are given for each month of FY 82 in Table 3.

Estimated annual catches for a given method and landing were determined using the formula:

$$E = \frac{B_e}{B_C} \times C$$

E = estimated annual catch

B_C = no. of censused boat trips using a given method

C = censused catch

and B_e = estimated total number of boat trips using a given method for FY 82, using the formula:

$$B_e = [(b.d)WE/H + (b.d)WD]bw + [(b.d)WE/H + (b.d)WD]gw$$

where: b = mean no. of boat trips/day, and
d = no. of available days, with D_g designating "good weather" days and D_w designating small-craft warning "bad-weather" days.

Data used in determining B_e and B_c are summarized in Table 2. As in Method 1 this analysis also takes into consideration low participation due to inclement weather.

Since only six days were censused and only 9 interviews were completed at Merizo Pier, the annual trolling catch for that landing was estimated as follows:

$$E = (D_a \times B \times C)we/h + (D_a \times B \times C)wd$$

where: E = estimated annual catch

B = no. of boats fishing/"good-weather" day

C = censused catch/boat/day

D_a = Number of available fishing days/year. Assuming that the same relationship of boats fishing on a "good-weather" day as opposed to a "small-craft-warning-day" from the Agana Boat also applies to Merizo, each D_w day = .654 g_w day for WE/H and .5 for WD. It is also assumed that the same 20 unfishable days apply for the entire island as well as the Agana Boat Basin.

No boats utilizing other methods were censused at Merizo Pier during FY 82.

RESULTS

Agana Boat Basin

Trolling

Estimated monthly and annual catch values, calculated by Method 1, are presented in Table 3. Estimated annual participation, effort and catch values for trolling from the Agana Boat Basin, calculated by Method 2, are presented in Table 4.

The values obtained by Method 1 are considered the most reliable of the two due to the greater precision of that method. Actual data obtained during the censuses appear in Tables 5 and 6.

Table 2. Determination of total number of fishing trips utilizing the Agana Boat Basin during FY 82 and calculation of bw/gw.

	<u>WE/H</u>	<u>WD</u>
No. of known pre-1700 hr. returns on a census day not censused:	5	4
No. of boats censused:	301	111
No. of boats missed after 1700 hrs:	24	4
<u>Total no. of boats on a census day:</u>	<u>331</u>	<u>119</u>
Total no. of boats on Dg census days:	305	105
No. of Dg census days:	<u>÷ 23</u>	<u>÷ 15</u>
No. of boats/Dg days:	= 13.26	= 7.0
Total no. boats on Dw census days:	26	14
No. of Dw census days:	<u>÷ 3</u>	<u>÷ 4</u>
<u>No. of boats/Dw day:</u>	<u>+ 8.67</u>	<u>= 3.5</u>
No. boats/Dg day (gw)	13.26	7.0
No. of Dg days	<u>x 96</u>	<u>x 183</u>
boat trips on Dg days =	1,272.96	1,281.0
No. boats/Dw day	8.67	3.5
No. of/Dw days	<u>x 15</u>	<u>x 46</u>
Boat trips on Dw days =	130.05	161.0
Total no. of boat trips/year (Be)	= 1,403.0 WE/H + 1,442.0 WD	
	= 2,845.0 for entire year.	

Table 3. Estimated monthly and annual trolling and bottomfishing catches at the Agana Boat Basin and factors used to derive it by Method 1.

Month	Type of Day	Bf No. of boats known fishing on a census day	Bc No. of boats intercepted	Da No. of available days in mo.	De No. of days lost due to bad weather	Dw No. small craft-warming days still fishable	Dc No. of days censused	Trolling			Bottomfishing	
								C Censused catch (kg)	E Estimated monthly catch (kg)	C Censused catch (kg)	E Estimated monthly catch (kg)	
Oct	WE/H WD	17 6	14 5	11 20	0 2	3 5	1.654 1	156.8 92.8	2,872.6	16.08 0	136.0	
Nov	WE/H WD	27 10	27 10	10 20	0 4	1 2	2 1	617.8 690.6	13,341.1	178.81 13.91	1,071.3	
Dec	WE/H WD	36 2	32 1	10 21	2 1	1 6	2.654 .5	705.8 40.0	5,019.0	13.51 0	43.8	
Jan	WE/H WD	34 19	24 17	11 20	0 0	1 2	3 2	547.1 497.6	8,037.9	89.72 43.73	915.9	
Feb	WE/H WD	26 17	25 15	9 19	0 1	0 5	2 2	983.1 736.6	11,068.8	42.57 85.01	945.7	
Mar	WE/H WD	29 10	27 9	9 22	0 0	4 10	1.654 1.5	1,981.1 487.1	15,931.1	19.05 3.65	140.2	
Apr	WE/H WD	29 13	28 12	9 21	0 0	3 4	2 2	1,005.4 258.3	6,804.1	14.52 79.13	874.5	
May	WE/H WD	23 6	22 6	11 20	0 0	1 4	2 1.5	363.5 97.7	3,195.9	16.44 0	91.5	
Jun	WE/H WD	27 13	27 13	8 22	0 0	0 4	2 1.5	786.7 451.1	9,161.3	237.88 35.16	1,420.3	
Jul	WE/H WD	28 2	25 2	11 20	2 5	0 1	2 1	928.1 134.6	6,629.3	78.16 0	393.9	
Aug	WE/H WD	33 13	30 13	9 22	0 0	1 3	2 2	876.1 538.2	9,686.5	107.19 48.38	1,006.1	
Sep	WE/H WD	20 2	19 1	9 21	1 6	0 0	2 1	425.8 16.3	2,527.0	259.46 292.5	552.0	
TOTAL:	WE/H WD	331 119	301 111	117 248	5 19	15 46	24.962 17.0	- -	94,265.6	- -	8,143.7	

*When a census day is also a "Dw" day, it is multiplied by $\frac{bw}{gw}$ to account for low participation on that day. Further explanation is provided in the text.

Table 4. Estimated annual participation, effort and catch for all fishing methods censused at the Agana Boat Basin during FY 82 calculated by Method 2.

Method	Est. no. of boat trips per year (Be)	Est. no. of persons per year*	of annual boat trips	Est. no. of boat hours	Est. no. of person- hours	Est. no. of gear- unit hrs.	Est. annual catch (kg) (E)	of total catch
Trolling	2,597.5	6,774.3	91.3	13,977.1	37,892.3	60,072.4	91,962.5	91.3
Bottomfishing	699.9	1,854.7	24.6	2,376.2	5,974.3	5,476.7	8,172.4	8.1
Spearfishing	34.1	68.2	1.2	48.4	103.7	103.7	219.6	0.2
Shrimp-trapping	19.9	53.1	0.7	-	-	16,523.6	351.6	0.3
Spin-casting	14.2	18.4	0.5	24.9	49.7	49.7	34.1	0.3
Longlining	5.7	22.8	0.2	37.1	148.2	3,705.0	38.8	0.4
All Methods:	2,845.0	7,412.7	118.8*	16,463.7	44,168.2	-	100,779.0	100.0

or (3,374.2 & 8,791.5) if considering 1 method as one trip.

Table 5. Actual monthly and annual effort, catch and CPUE Trolling data collected at the Agana Boat Basin during FY 82.

Month	No. of weekends and holidays censused	No. of weekdays censused	No. of boats	Trolling hours	No. of persons	Person-hours	No. of lines	Line-hours	Catch (kg)	Catch/boat-hour (kg)	Catch/person-hour (kg)	Catch/line-hour (kg)
Oct	2	1	16	61.0	45	171	66	263.3	249.6	4.09	1.46	.95
Nov	2	1	31	166.8	96	546.3	133.2	766.9	1,308.5	7.84	2.40	1.71
Dec	3	1	32	176.9	84.5	457	131.9	758.0	745.8	4.22	1.63	.98
Jan	3	2	38	197.5	99	557.5	155.4	881.8	1,044.7	5.29	1.87	1.18
Feb	2	2	49	266.4	137.4	764.3	195.8	1,138.2	1,719.7	6.45	2.25	1.51
Mar	2	2	34	213.8	85.5	554.3	141.8	926.8	2,468.2	11.54	4.45	2.66
Apr	2	2	40	210.3	106	605.9	153.2	863.4	1,263.7	6.01	2.09	1.46
May	2	2	25	122.0	58	276	94	480.8	461.2	3.78	1.67	.96
Jun	2	2	35	179.3	73.2	458.5	147.3	759.3	1,237.8	6.90	2.70	1.63
Jul	2	1	25	165.2	62	403.2	104	709.8	1,062.7	6.43	2.64	1.50
Aug	2	2	36	190.4	92.9	486.5	142.5	817.5	1,414.3	7.43	2.91	1.73
Sep	2	1	18	89.8	49	248.3	78.5	399.3	442.1	4.92	1.78	1.11
TOTAL	26	19	379	2,039.4	988.5	5,528.8	1,543.4	8,765.1	13,418.2	6.58	2.43	1.53

*July 17 - 19 Marianas Fishing Derby, and Sept. 4-5 Rota Fish Derby days are treated as normal fishing days in this analysis.
 ** - See comments, p ____.

Table 6. Actual annual participation, effort, catch and CPUE data collected at the Agana Boat Basin for all fishing methods during FY 82.

Method	No. of boats (Bc)	Boat-hours*	No. of persons	Person-hours	Gear-units	Gear-unit hours	Catch/ (kg) (C)	Catch/ boat-hr. (kg)
Trolling	379	2,039.4	988.5	5,528.8	1,543.4 lines	8,765.1	13,418.2	6.58
Bottomfishing	102	346.3	270.3	870.7	238.7 lines	798.2	1,194.2	3.45
Spearfishing	5	7.1	10	15.2	10 spears	15.2	32.23	4.54
Shrimp trapping	3	-	8	-	159 traps	47.0	53.0	-
Spin casting	2	3.5	4	7	4 lines	7	4.79	1.37
Longlining	1	6.5	4	26.0	100 hooks	650	6.8	1.05
All Methods:	415	2,402.8**	1,284.8	6,447.7**	-	-	14,709.2	6.12

Table 6. Continued

Method	Catch/ person-hr. (kg)	Catch/ gear-hr. (kg)	Persons/ boat	Person-hr./ boat	Fishing hr./ boat	Fishing-hr person/boat	Gear units/boat	Gear-hr./ boat	Catch boat trln (kg)
Trolling	2.43	1.53	2.608	14.588	5.381	5.593	4.072	23.127	35.40
Bottomfishing	1.37	1.50	2.650	8.536	3.395	2.514	2.340	7.925	11.71
Spearfishing	2.12	2.12	2.0	3.040	1.42	1.52	2.0	3.040	6.45
Shrimp trapping	-	0.33	2.667	-	-	-	53.0	830.333	17.67
Spin casting	0.68	0.68	2.0	3.5	1.75	1.75	2.0	3.5	2.40
Longlining	0.26	0.01	4	26.0	6.5	6.5	100 hooks	650	6.8
All Methods:	2.28	-	2.611	13.185**	4.913**	1.892**	-	-	29.90

*Only hours spent fishing are reported

**Excludes shrimp trapping

An estimated 6,774 persons spent 37,892 person-hours trolling 1.56 lines each during FY 82, catching an estimated 94.3 metric tons of fishes. This represents a slight increase in participation, but a slight decrease in effort over the previous years. The total catch and CPUE, however, increased considerably over those estimated for FY 81. Much of this apparent increase may be due to the substitution of previous year's data for the January and February 1981 estimates due to a hiatus in the census during those months. Since these two months often correspond with the peak harvest of mahimahi, the dominant species in the annual catch, and since overall participation has been increasing over the last few years, the estimated catches of Jan-Feb 1981 may be too low.

As in previous years, five species accounted for the vast majority of the catch (96.2% by weight; Table 7). These were mahimahi (Coryphaena hippurus, 27.8%), skipjack tuna (Katsuwonus pelamis 27.4%), yellowfin tuna (Thunnus albacares 17.4%), wahoo (Acanthocybium solandri, 16.5) and blue marlin (Makaira nigricans, 7.1%). Scombrids collectively accounted for 62.1% of the catch with landings totalling 58.5 metric tons. Other species of less importance included the great barracuda (Sphyraena barracuda), black marlin (Makaira indica)*, rainbow runner (Elagatis bipinnulatus) and other carangids, snappers (Lutjanidae), and an occasional carcharhinid shark.

The most striking characteristic of Guam's trolling catch is the seasonality exhibited by the dominant species (Fig. 1). These large seasonal catches form for the bulk of the offshore harvest and greatly overshadow concurrent landings of other species "not in season". This is particularly true for mahimahi which peaked in March 1982 with a catch of 12.2 metric tons, but virtually disappeared by June. As in previous years this was followed by an increase in the abundance of skipjack tuna and blue marlin during the summer months. The relative abundance of skipjack tuna however, was not as pronounced during the month of June, as was the catch of blue marlin with relatively large catches spread throughout other months of the year. Yellowfin tuna were most abundant during July and August, but also formed a significant portion of the catch throughout the year. The wahoo catch of FY 82 was unusually large, with a sharp peak in Nov. 1981 (7.5 metric tons), followed by a steady decrease throughout the remainder of the year. In general, the seasonal patterns of FY 82 are consistent with those of previous years.

Biological data gathered during FY 82 indicate that most of Guam's trolling catch consists of juvenile and sub-adult fishes. Examination of gonads revealed that the catches of mahimahi and wahoo consisted mostly of immature or maturing fish. The only individuals of these species of either sex that were in spawning condition appeared from May to June, months when both are relatively uncommon. Occasionally, large individuals of both species were caught at other times of the year. However, most of these examined were not ready to spawn nor had they recently spawned. While a few ripe male and female skipjack tuna appeared during various times of the year, most were immature or maturing. Virtually none of the yellowfin tuna examined during FY 82 were fully mature. It is highly unusual for large yellowfin (over 100 kg) or skipjack tuna (over 10 kg) to be caught off Guam. This is probably due to the predominantly high sea-surface temperatures and deep thermocline prevalent throughout the year. This may prevent large tunas, which

*recorded for the first time in Guam's censused catch.

Table 7. Estimated weight (Kg) of each species landed.

Species	1981 Oct	Nov	Dec	1982 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total FY 82	of FY 82 Total
<u>Coryphaena hippurus</u>	397.1	342.6	678.1	1,334.2	6,865.0	12,217.0	3,256.9	789.3	88.1	103.6	26.7	88.7	26,187.3	27.8
<u>Elagatis bipinnulatus</u>	155.4	14.3	154.5	15.4	38.0	9.7	0	13.9	52.5	14.4	8.9	103.0	580.0	0.6
<u>Sphyræna barracuda</u>	154.3	177.6	12.7	106.1	433.4	40.7	103.9	0	45.2	0	95.9	0	1,173.6	1.2
<u>Acanthocybium solandri</u>	550.2	7,473.0	1,406.5	1,475.7	1,602.9	752.7	436.7	327.8	667.4	424.9	299.3	158.4	15,575.5	16.5
<u>Euthynnus affinis</u>	62.2	0	8.7	19.2	21.9	31.0	0	5.5	0	28.1	0	24.0	200.6	0.2
<u>Katsuwonus pelamis</u>	484.6	3,398.5	1,852.7	3,808.1	1,154.7	1,784.7	2,058.9	1,223.8	4,766.4	2,594.0	2,407.1	276.8	25,810.3	27.4
<u>Thunnus albacares</u>	552.5	874.9	620.2	1,262.7	756.1	850.8	588.5	424.8	1,127.0	2,583.4	5,939.0	784.2	16,364.1	17.4
<u>Makaira nigricans</u>	0	949.3	268.8	0	0	258.0	0	401.9	2,403.5	713.2	913.8	735.6	6,644.1	7.0
<u>M. indicus</u>	516.8	0	0	0	0	0	270.8	0	0	0	0	0	787.6	0.8
Other	0	110.2	10.1	12.3	202.9	0	84.5	9.0	9.6	169.7	0	358.1	966.5*	1.0
TOTAL:	2,872.6	13,341.1	5,010.0	8,037.9	11,068.8	15,931.1	6,804.1	3,195.9	9,161.3	6,629.3	9,686.5	2,527.0	94,265.6	99.9
Expanded total catch (kg)	11.5	10.20	6.72	7.69	6.44	6.45	5.38	6.93	7.40	6.24	6.85	5.72	7.02	
Observed catch (kg)														

*includes: sharks
other scombrids

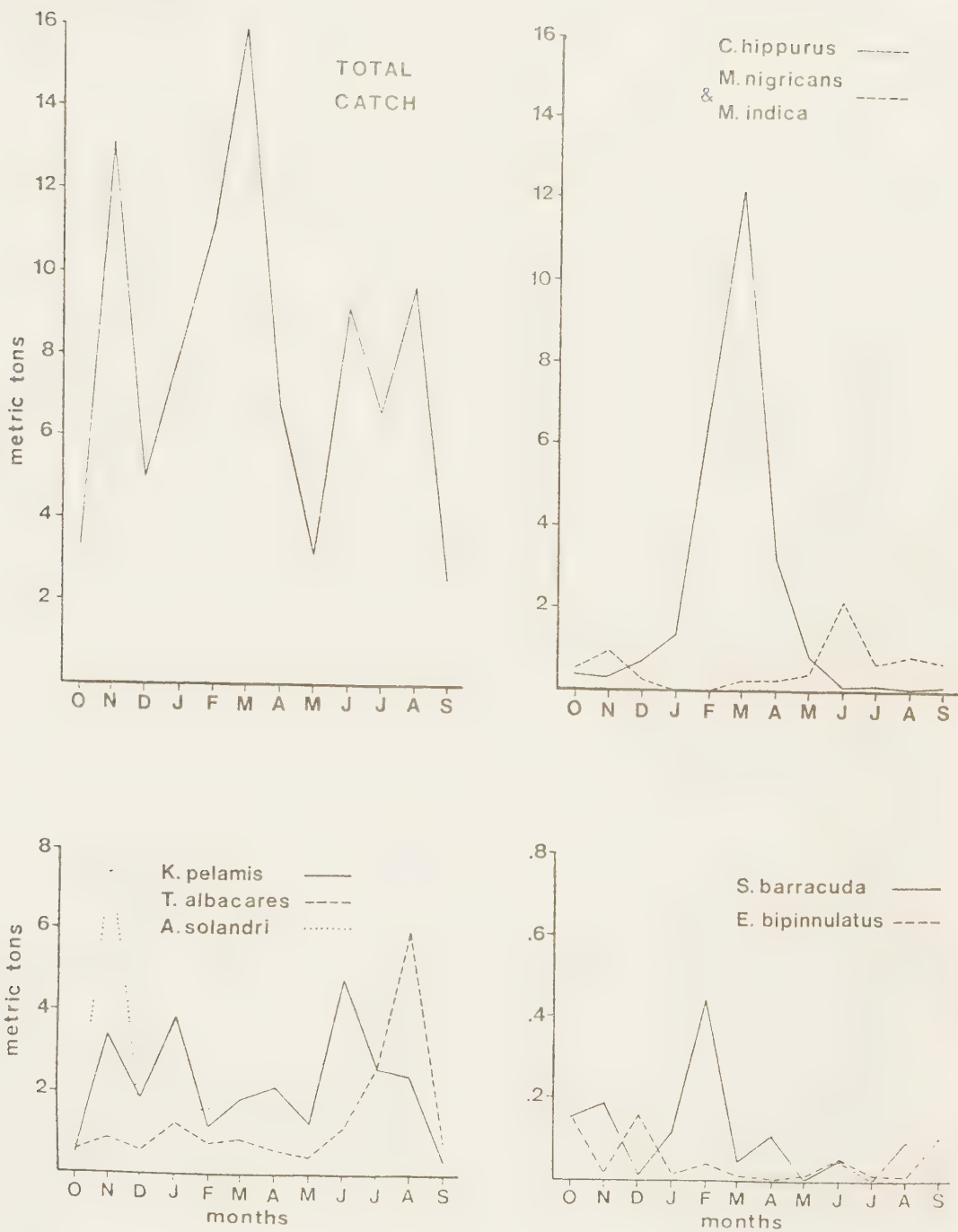


Figure 1. Seasonal trends in the offshore fishery catch landed at the Agana Boat Basin during FY 82.

maintain elevated body temperatures, from spending much time in warm surface water where they would be caught by trolling. Consequently, small, immature fish predominate the catch.

Bottomfishing

Estimated monthly and annual catch values, calculated by Method 1, appear in Table 3. Estimated annual participation, effort and catch values for bottomfishing by boats from the Agana Boat Basin, calculated by Method 2, appear in Table 4. Estimates calculated by Method 1 are considered the more reliable of the two. Actual data obtained during the census appear in Tables 6 and 8.

An estimated 1,855 persons spent 5,974 person-hours catching 8.1 metric tons of fishes during FY 82. This represents a considerable increase in participation, effort, and catch over previous years. The number of boat trips in which bottomfishing was engaged nearly doubled during the past year, from 362 in FY 81 to 700 in FY 82. CPUE also increased slightly (from 1.32 kg/line-hr to 1.50 kg/line-hr), resulting in a much greater catch (8.1 vs. 5.4 metric tons). Due to the current sampling scheme, in which only late afternoon and evening returning boats are censused, it is possible that bottomfishing is undersampled relative to trolling. Although an effort was made to account for early returning boats, bottomfishing can be conducted 24 hours-a-day while trolling is limited to daylight, or near-daylight hours. The method used here assumes that the same ratio of trolling to bottomfishing effort applies to uncensused as well as censused time periods. This may not be accurate. However, the relative proportion of bottomfish to trolling fish caught during FY 82 did not differ from those of FY 81 or previous years in which censuses were conducted over a broader time span on a given census day.

Unlike catches of major trolling species, bottomfish catches were non-seasonal. As in previous years, the most important species by weight (Table 9) were snappers (family Lutjanidae) which comprised 41% of the catch. Most were deepwater forms generally caught near the 200 m contour. These included Lehi (Aphareus rutilanus), Onaga (Etelis coruscans)*, Ehu (Etelis carbunculus)*, Gindai (Pristipomoides zonatus), and Kalikali and related species (Pristipomoides auricilla, P. flavipinnis, P. filamentous, P. seiboldi and P. amoenus), which accounted for 33% of the overall catch. The remainder of the lutjanid catch (8% of the overall bottomfish catch) consisted of shallower water forms such as Uku (Aprion virescens) and various species of Lutjanus. The second most important group of bottomfishes caught were emperors (family Lethrinidae), primarily the Mafute (Lethrinus ruprioperculatus) which composed 27.7% of the catch. These, and groupers (family Serranidae) and jacks (family Carangidae), which each composed 6.4% of the catch, are generally caught at depths of less than 200 m. Other groups that formed a significant portion of the catch were wrasses (Labridae), triggerfishes (Balistidae) and goatfishes (Mullidae), all of which are also usually hooked at depths less than 200 m.

*Anderson (1981) has determined that the valid name for the species commonly known as the Onaga is Etelis coruscans rather than E. carbunculus, and that the valid name for the species commonly known as the Ehu is E. carbunculus rather than E. marshi.

Table 8. Actual monthly and annual effort, catch and CPUE bottomfishing data collected at the Agana Boat Basin during FY 82.

Month	No. of weekend and holidays censused	No. of weekdays censused	No. of boats	Bottom-fishing hours	No. of persons	Person-hours	No. of lines	Line-hours	Catch (kg)	Catch/Boat-hour (kg)	Catch/Person-hour (kg)	Catch/Line-hour (kg)
Oct.	2	1	6	14.0	18	40.0	18	38.5	16.1	1.15	0.40	0.42
Nov.	2	1	10	34.5	33	103.5	19	63.0	192.7	5.59	1.86	3.06
Dec.	3	1	7	17.0	16	43.0	14.5	33.0	13.5	0.79	0.31	0.41
Jan.*	2	2	13	48.5	31	101.5	22	75.5	133.4	2.75	1.31	1.77
Feb.	2	2	13	36.9	36.7	90.7	24.6	68.7	127.6	3.46	1.41	1.86
Mar.	2	2	4	10.5	10	20	11	21	25.4	2.51	1.32	1.03
Apr.	2	2	8	23.6	18	62.1	17	68.7	93.7	3.97	1.51	1.36
May	2	2	2	6	6	18	7	22	16.4	2.73	0.91	0.75
Jun	2	2	14	55.7	36	153.6	32	139.6	273.0	4.90	1.78	1.96
Jul.	2	1	6	16.8	13	37.0	13.5	54.0	78.2	4.65	2.11	1.45
Aug.	2	2	11	45.0	33.6	126.0	32.1	126.7	155.6	3.46	1.23	1.23
Sep.	2	1	8	37.8	19	75.3	28	109.5	68.1	1.80	0.90	0.62
TOTAL:	26	19	102	346.3	270.3	870.7	238.7	798.2	1,194.7	3.45	1.37	1.50

= hr/boat for year

* Includes 1 boat on a two-day trip. One-half of the total catch and effort was considered to have occurred on the census day.

Table 9. Estimated annual catch composition based on bottomfishing data collected at the Agana Boat Basin during FY 82.

<u>Species Group</u>	<u>Estimated Catch</u> <u>Kg</u>	<u>% by</u> <u>Wt</u>
Lutjanidae	3,337.04	41.0
(deepwater spp.)	2,687.61	33.0)
(shallow reef spp.)	649.43	8.0)
Lethrinidae	2,253.73	27.7
Serranidae	518.84	6.4
Carangidae	517.36	6.4
Labridae	118.91	1.5
Balistidae	89.62	1.1
Mullidae	52.51	0.6
Other*	566.42	7.0
Unknown composition	<u>689.25</u>	<u>8.5</u>
Total	8,143.68	100.2*
*including:		
<u>Gymnosarda unicolor</u>	258.48	3.2
Sphyraenidae (primarily <u>S. barracuda</u>)	117.43	1.4
<u>Trienodon obesus</u>	36.44	0.4
Holocentridae	14.51	0.2
Triodontidae	12.15	0.1
Gempylidae	12.15	0.1
Scorpaenidae	4.72	0.1
<u>Alutera scripta</u>	3.37	-

Spearfishing

Estimated annual participation, effort and catch values for spearfishing from the Agana Boat Basin, calculated by Method 2, are presented in Table 4. An estimated 34 boats carrying 58 spearfishermen utilized the Agana Boat Basin during FY 82, representing a drastic decrease in participation from FY 80 and FY 81. However, the catch per person hour increased to 2.12 kg, up considerably from .82 kg in FY 80 and 1.36 kg in FY 81 (Table 6). The total catch of FY 82, 220 kg, was considerably lower than that of previous years. These figures however, may reflect a bias in the sampling method more than a real change in the fishery, since only five boats carrying spearfishermen were censused. This unusually small proportion of the total number of boats censused may be due to the concentration of sampling effort during the late afternoon and evenings. Since spearfishing frequently takes place late at night or during the morning, it is likely that a disproportionate number of spearfishing parties return to port undetected. This may also explain the apparent drop in spearfishing activity from FY 80 to FY 81, since aspects of the current sampling method were utilized throughout much of FY 81 as well. If it is assumed that the level of spearfishing activity found during the currently used 5-hour census period is representative of spearfishing activity occurring during the remainder of a census day, then the annual catch can be roughly estimated by multiplying:

$$\begin{aligned} & (1) \quad 34.1 \text{ boats/year (Table 4)} \times \frac{412 \text{ boats censused} + \text{boats censused}}{421 \text{ boats missed}} \\ \text{by } & (2) \quad \frac{412 \text{ boats censused}}{421 \text{ boats returning during census period}} \\ \text{by } & (3) \quad \frac{24 \text{ hrs/day}}{5 \text{ hr census period}} \\ \text{by } & (4) \quad 6.45 \text{ kg/boat (Table 8)}. \end{aligned}$$

This yields a hypothetical spearfishing catch of 1,034.6 kg during FY 82, which is a more realistic figure than that calculated by Method 2.

Other Fishing Methods

In addition to the three primary fishing methods discussed above, a limited amount of shrimp-trapping, spin-casting, and longlining was conducted from boats utilizing the Agana Boat Basin. Ikashibi may have been practiced as well, on rare occasions, but no fishermen utilizing this method were interviewed. Actual data used for evaluating these fisheries by Method 2 is presented in Table 6.

It is obvious from the low number of interviews that these fishing methods are infrequently practiced. Due to the small sample size, annual estimates of participation, effort and catch (Table 4) may not be very accurate, but are acceptable considering the relatively low contribution of these fisheries to the total offshore catch.

Commercial shrimp-trapping was initiated by one boat berthed at the Agana Boat Basin during FY 82. This fishery was short-lived, having proved economically unfeasible after a few months of operation. An estimated 20 boats trips harvested an estimated 352 kg of deep-water

shrimp (Heterocarpus spp.) or approximately 17.6 kg/trip. This uneconomical harvest was probably due to the small size of the boat which precluded the ability to set large numbers of traps, or reach more distant grounds which according to recent surveys, are more productive (Hobart, 1982).

Spin-casting with light tackle from an anchored or slowly moving boat was practiced on an estimated 14 boat trips by 50 persons, and yielded an estimated catch of 34.1 kg. This is probably an underestimate since light tackle is used to a greater extent for trolling or bottomfishing. It is likely that a portion of the spin-casting catch was recorded under these methods during FY 82. In previous years, spin-casting was analyzed as either trolling or bottomfishing.

Longlining was initiated by one boat berthed at the Agana Boat Basin during FY 82. Only one interview was conducted. The interviewed party had set a 4 Km-long line with only 100 hooks for a maximum set time of 6.5 hrs., and caught only 6.8 kg of mahimahi (Table 7). An estimated 6 trips which yielded 38.8 kg. were conducted during FY 82. Since the size of the line was increased significantly after the one interview (based on subsequent conversations with the fisherman), it is likely that the catch was significantly greater than the calculated estimate.

Merizo Pier

Actual data used for estimating the trolling catch landed at Merizo Pier are summarized in Table 10. No other fishing methods were encountered on the six days censused, although undoubtedly bottomfishing and spearfishing occurred throughout the year.

The parties interviewed collectively fished 126.4 line hours for a CPUE of 1.31 kg/line-hour, or 18.33 kg/boat/day, resulting in an estimated annual catch of 14.8 metric tons.

Other Landings

No data was available for fishing activities conducted on boats returning to other landings. The estimate of four boats/day returning to all other sites combined, which was utilized in the FY 80 and FY 81 offshore analyses, is again used here. This assumes that participation levels have remained constant at these landings. Incidental observations during the past three years indicate that this assumption is reasonable. However, the size of vessels, and possibly the relative proportion of fishing methods utilized, appears to be different from those of boats utilizing the Agana Boat Basin. The catch rate of 35.4 kg/boat for all methods for fish landed at the Agana Boat Basin is influenced by large catches by a few full-time fishermen and a few non-trailored large vessels that regularly fish highly productive offshore banks. For this reason, it is assumed that catch rates for boats launched at sites other than the Agana Boat Basin or Merizo Pier are closer to those for boats operating from Merizo pier, (18.3 kg/boat) than for boats operating out of the Agana Boat Basin. Multiplying 18.3 kg/boat by 4 boat trips/day by 365 days/year yields an annual catch of 26,762 kg. Assuming each method accounted for the same proportion of this catch, as it did for those landed at the Agana Boat Basin and Merizo Pier, 24,618 kg were caught by trolling, 1,840 kg by bottomfishing and 227 kg by spearfishing.

Table 10. Actual participation, effort, and catch data collected at Merizo Pier for trolling during FY 82 and the derived annual catch estimates.

No. of boats censused:	9
No. of boat-hours fished:	30.65
No. of persons:	36
No. of person-hours:	127.25
No. of lines:	37
No. of line-hours:	126.35
Catch (Kg):	164.95
Catch/boat/day:	18.33
Catch/boat-hour:	5.38
Catch/man-hour:	1.30
Catch/line-hour:	1.31
No. of known additional fishing trips on census days <u>not</u> interviewed:	4
No. of boats/"gw" (WD)	2.33
No. of boats/"gw" (WE/H)	3.0
No. of available WD	206.0
No. of available WE/H	105.8
Estimated annual catch (Kg):	14,616.5

Overview of Results

Personnel limitations and logistic restraints precluded the utilization of a sampling scheme that sampled all methods of offshore fishing and all landings equally well.

Best estimates of catches by specific offshore methods landed at specific sites were derived by utilizing a combination of analysis procedures. Our best estimates indicate an FY 82 island-wide catch of 144.8 metric tons, of which 103.6 m.t. was landed at the Agana Boat Basin, 14.6 m.t. at Merizo Pier and 26.8 m.t. elsewhere. An estimated 133.6 m.t. were caught by trolling, 9.9 m.t. by bottomfishing and 1.2 m.t. by spearfishing.

REFERENCES CITED

- Anderson, W.D. Jr. 1981. A new species of Indo-West Pacific Etelis (Pisces: Lutjanidae), with comments on other species in the Genus. Copeia. 1981(4): 820-825.
- Hobart, W., Ed. 1982. Marianas Cruises Locate Fish Resources, New Bank Marine Fisheries Review. 44(11):25.

Report prepared by Robert F. Myers



PROJECT TITLE: Sixth Annual Marianas Fishing Derby

PERIOD COVERED: July 17-19, 1982

By all standards, the 1982 Sixth Annual Marianas Fishing Derby was a success. Derby participation has continued to grow as more anglers come from farther away to catch "the big one." As always, the Guam Fishing and Boating Association and the Derby Committee itself have managed to keep pace with this growth and ensure a well organized and successful Derby. The Division of Aquatic and Wildlife Resources (DAWR) thanks the Derby organizers for their shoreside support and the fishermen for their cooperation in providing catch information by allowing measurements to be taken by DAWR fisheries biologists after a long day's fishing.

Prizes for the 1982 Marianas Fishing Derby were awarded to the first, second and third place fish in four species categories - billfish, yellowfin tuna, wahoo and mahimahi. Additional prizes were given for the total number of pieces caught.

PARTICIPATION

If you left the dock in a boat with three anglers pulling four lines and spent nine hours and 24 minutes catching one and one-third fish totaling, by weight, 33.5 pounds, you were the "average" fisherman. As was the case last year, onshore derby stations were established at the Agana Boat Basin and at Merizo Pier. Despite the fact that last year the southern banks were by far the most productive, again, 80% of 199 separate boat trips left from the Agana Boat Basin to go north. Participation was slightly up over last year with an average of 212 persons making 66 trips per day as opposed to 195 anglers averaging 62 trips per day in 1981. Fishing effort was slightly lower, but not significantly so. The average length of a fishing trip was 9.4 hours. Total fishing effort was estimated at 6,044 person-hours and "soaking time" was estimated at a total 7,742 line-hours.

CATCH

From Table 1, it can be seen that 1982 was a good year for yellowfin tuna, with 205 pieces totaling 2,377 kg being boated. Additionally, a surprising number of mahimahi were landed during the 1982 Derby, 14 in all. The wahoo catch was down about 50% from last year and the marlin made themselves scarce. Although the 1982 marlin catch was about one third that of the 1981 catch in terms of numbers, the average size was larger. Because the yellowfin were biting, more fish were landed in 1982 than in any previous Derby, however, the weight of the total catch did not quite measure up to that of 1981 for want of the elusive "big ones."

FISHING AREAS

As was the case with the 1981 contest, the best catches in terms of numbers and weight were made near the southern banks. Over half of all fish reported were caught near either Galvez Bank or Santa Rosa Reef. However, in 1982, the winning fish in all but the mahimahi category were caught by

TABLE 1. CATCH COMPARISONS FOR PREVIOUS MARIANAS FISHING DERBIES*
Weights are expressed in kilograms.

	1977	1978	1979	1980	1981	1982
MARLIN						
no. caught	9	9	6	12	34	12
total weight (kg)	933	511	703	727	2005	852
avg. weight (kg)	104	56.8	117	60.6	59.0	71.0
winning fish (kg)	192	75.2	238	139	145	132
YELLOWFIN						
no. caught	18**	11	34	50	109	205
total weight (kg)	240	255	637	308	1156	2377
avg. weight (kg)	8.4	23.2	18.7	6.2	10.6	11.6
winning fish (kg)	46.3	56.8	67.7	51.1	47.7	61.1
WAHOO						
no. caught	7	9	11	12	13	60
total weight (kg)	90.9	102	116	161	543	264
avg. weight (kg)	10.0	11.4	10.5	13.4	9.0	8.0
winning fish (kg)	22.3	18.9	19.7	23.4	17.0	22.7
MAHIMAHI						
no. caught	2	4	5	3	1	14
total weight (kg)	13.6	26.4	52.6	39.3	0.8	63.7
avg. weight (kg)	6.8	6.6	10.5	13.1	-	4.6
winning fish (kg)	8.9	8.9	14.8	15.9	0.8	14.8
TOTAL CATCH						
no. caught	36	33	56	77	177	264
total weight (kg)	1277	895	1508	1235	3705	3029

those "going north". While the northern and southern banks combined produced over 75% of the 1982 catch, most of the winning fish were caught in open water. The first place marlin and wahoo were hooked off of Ritidian Point as was the second place mahimahi. The top yellowfin and the third place marlin hit around 10 miles offshore of Hospital Point. The biggest mahimahi was taken on Galvez Bank. Table 2 shows the percent of the total catch that was taken on the major fishing grounds. These values can be considered low estimates, since not all fishermen reported the areas in which their fish were hooked.

Table 2. Percent of Total 1982 Derby Catch Taken at the Major Fishing Grounds (% by number, % by weight)

	Marlin	Yellowfin	Wahoo	Mahimahi	Total
Rota Bank	8%, 6%	22%, 18%	18%, 20%	36%, 22%	22%, 21%
Galvez Bank	42%, 41%	29%, 23%	24%, 20%	7%, 23%	28%, 41%
Santa Rosa Reef	8%, 5%	24%, 29%	6%, 6%	-	20%, 23%
11 Mile (17 Mile) Reef	-	7%, 6%	-	7%, 5%	6%, 6%

CATCH RECORDS

Since all Derby catch and participation data are obtained from daily catch records submitted by the derby participants, it is necessary that fishermen cooperate by completing their forms as accurately as possible. In an effort to improve future response and reporting accuracy, the following paragraph will appear in the 1983 Guam/Marianas International Fishing Derby Program report:

"Every boat will be given a 'catch record' each day when it leaves the dock. These forms are the only way that biologists can get a picture of what happened 'out there'. We ask that every boat fill one out for each trip WHETHER OR NOT THERE WAS ANY CATCH. Figure 1 is a facsimile of the front of your form. Fill in (1) your GM number or boat's name if you do not have a GM number; (2) the date; (3) the time at which you check out with Derby Officials; (5) number of fishermen on board (check the appropriate box); and (6) the number of lines you are trolling. Note the total time that was not spent fishing (i.e. engine trouble, tangled lines or just resting) in (7). Indicate whether or not you saw any porpoise (8) and if so, about where (9) by using the location map (Figure 2) on the back of your catch record. In column (10), break down your catch into number of pieces of marlin, yellowfin, wahoo and mahimahi and tell us the best you can where they were caught using the location map on the back (11). You need not fill in (12). Finally note the time that you check in with Derby Officials (4). Fisheries biologists at the check-in station will fill out the rest of the form. Filling out this form should not take more than a few minutes and will help us generate a picture

MARIANAS FISHING DERBY
FISHERMEN'S CATCH RECORD

1) BOAT: _____ (2) DATE: _____ (3) CHECK OUT: _____ (4) CHECK IN: _____

5) NUMBER OF FISHERMEN: 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐

6) NUMBER OF LINES: 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐

7) LOST TIME: _____ (8) PORPOISE TODAY? NO ☐ YES ☐ (9) AT: _____

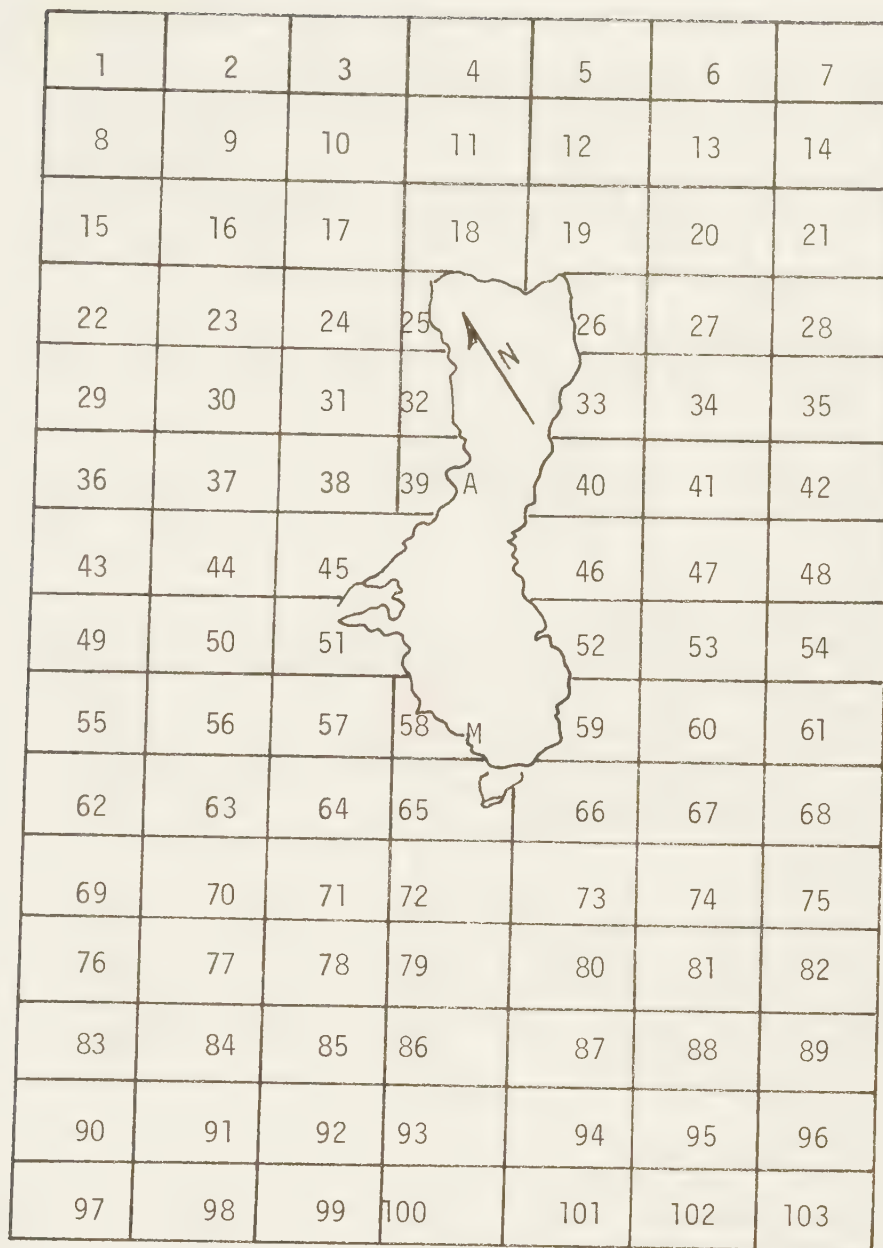
SPECIES	(10) # CAUGHT	(11) FISHING AREAS	(12) TOTAL WEIGHT (Kg)
TOTAL CATCH:			
MARLIN			
YELLOWFIN			
WAHOO			
MAHIMAHI			

	AREA	WGT.	Ln (cm)	SEX	GUT	AREA	WGT.	Ln (cm)	SEX	GUT
MARLIN										
YELLOWFIN										
WAHOO										
MAHIMAHI										

TOTAL WEIGHTS ARE:
INDIV. WEIGHTS:

☐ ESTIMATED
☐ ESTIMATED

☐ ACTUAL SCALE WEIGHTS
☐ ACTUAL SCALE WEIGHTS



FISHING AREA NUMBERS:

FILL IN ON OTHER SIDE

GRID SCALE:

APPROX. 5 mi. x .8 mi.

4 = Rota Bank

12 = 45° Bank

24/25 = Ritidian Pt.

19 = Pati Pt.

39 = Hospital Pt.

51 = Orote Pt.

70 = 11mi. (17mi.) Reef

85 = Galvez Bank

92 = Baby Banks

100 = Santa Rosa Reef

Figure 2. The island of Guam with MFD fishing areas.

A = Agana Boat Basin; M = Merizo Pier.

of catch and fishing effort that may be valuable in helping to preserve local fish stocks for local fishermen.

We hope that this clarification of reporting procedures will increase the efficiency of data compilation efforts and result in a more accurate derby analysis.

Report prepared by Deborah A. Grosenbaugh

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-19

SUB-PROJECT NO.: F

STUDY NO.: F-1

JOB NO.: 2

JOB TITLE: Inshore Creel Census

PERIOD COVERED: October 1, 1981 to September 30, 1982

SUMMARY

Inshore creel census interviews were conducted monthly from October, 1981 to September, 1982. Three shoreline routes were censused twice per month. An estimated total of 9232 kg of fish was caught. Hook and line fishing was the most popular method, accounting for over 71% of the gear-hours. Surround netting was the most successful in terms of catch yielding over 35% by weight. Other major inshore fishing methods include cast netting, gill netting, spearfishing, and gaff and hook fishing.

BACKGROUND

Effective management of the island's fishery resources requires accumulating data on fishing pressure, types of fishing methods and annual harvest. To this end, the Division of Aquatic and Wildlife Resources has been conducting inshore fishing interviews with fishermen for the past eighteen years.

OBJECTIVES

- I. To monitor trends in types and results of different fishing methods, areas fished, and types and amounts of each species taken by inshore fishing activities. This information will be made available to the fishermen so that they may use it to improve their catch rates.
- II. To chart variations in standing crop, species composition, and/or distribution patterns for various areas, and to determine if these variations occur in a seasonal or otherwise predictable manner.
- III. To make annual estimates of the total fish catch for Guam.
- IV. To create a table of length/weight conversion constants for Guam's popular inshore and game fishes.

PROCEDURES

Inshore creel census interviews were conducted monthly during the FY 1982 report period (October 1981 - September 1982). Censuses were taken along three shoreline routes (Figure 1), which include the areas of heaviest fishing pressure on Guam. Each route was censused twice per month (once on a weekday and once on a holiday), except when prevented by weather conditions or personnel shortages. Dates were chosen by lottery, and no two routes were censused on the same day.

RESULTS

The major inshore fishing methods include hook and line fishing, cast netting, gill netting, surround netting and spearfishing. In addition, lobsters, crabs, echinoderms and shellfish were harvested with a variety of gear which included hooks, short spears and gathering by hand.

Actual censused data for each fishing method are presented in Tables 1a - 6a. Tables 1b - 6b present catch-per-unit-effort values derived from the actual census data and monthly and annual estimates of participation, effort and catch. Estimated values represent the sums of computed mean catch and effort values for both weekdays and holidays that were multiplied by the number of weekdays and holidays, respectively, for each month. These estimates do not account for fishing that occurred at times of day other than during the census periods, fishing in uncensused areas, nighttime fishing activities or illegal fishing methods such as the use of poisons or explosives. It should be noted that in past years, total creel census estimates have been doubled as a form of correction factor. However, since this manipulation of the data is an arbitrary one, we are discontinuing the practice. The total estimates will be reported directly from the data expansions until a system of correction factors is devised that is comparable to those that have been applied to the offshore and Cocos Lagoon fishing activity data. Table 7 summarizes the expanded monthly and annual catch and effort data by fishing method for FY 1982. These data are expressed graphically in Figures 2 through 8.

A minimum estimated total of 9232 kg of fish was caught through the use of all six of the major inshore fishing methods in FY 82 (Table 7). This catch resulted from a total effort of 32,096 person-hours or 25,978 gear-hours. Approximately 0.38 and 0.94 kg of fish were taken per person-hour and gear-hour, respectively. Over 100 species of fish from 45 families were represented in the catch. However, surgeonfish (Acanthuridae), jacks (Carangidae), rabbitfish (Siganidae), goatfish (Mullidae), and mullet (Mugilidae) were by far the most abundant.

As in previous years, hook and line fishing was the most popular method, accounting for 48.5% of the total person-hours and 63.9% of the total gear-hours. Success with hook and line gear still remains lower than any other fishing method, averaging 0.13 kg per fishing hour. This method produced 1957 kg or approximately 21% of the total yearly catch. The greatest effort and largest catch for hook and line occurred in the late summer and early fall, as a result of the annual increase in atulai (Selar crumenophthalmus) at the Agana Boat Basin.

Effort expended in the various net fishing methods was second to that of hook and line fishing. Most popular, in terms of person-hours, were surround netting (18.0%), gill netting (13.1%) and cast netting (12.4%)



Figure 1. The island of Guam. The Inshore Fishing Census Regions are as follows: Region #1 - Gun Beach to Adelup Pt.
Region #2 - Adelup Pt. to Nimitz Beach
Region #3 - Toguan Bay to Pago Bay

Table 1a. Hook and Line Creel Census Data, summarized by month for fiscal year 1982.

MONTH	Number of Persons	Person- Hours	No. of Gear Units	Gear- Hours	Catch (Kg)
October	255	701	256	748	114
November	142	289	152	317	22
December	180	190	172	224	16
January	97	131	103	160	8
February	64	88	60	87	10
March	100	140	100	136	16
April	56	95	56	98	13
May	52	60	59	74	14
June	131	147	120	124	24
July	167	193	159	172	19
August	165	295	176	340	29
September	171	74	167	87	5
TOTAL	1580	2403	1583	2567	290

Table 1b. Hook and Line Data, expanded from Table 1a to yield total monthly and annual estimates for FY 1982.

MONTH	Number of Persons	Person- Hours	Gear- Hours	Kg/P-HR	Kg/G-HR	Catch (Kg)
October	1550	4270	4540	0.17	0.16	740
November	945	1930	2120	0.07	0.07	139
December	1090	1140	1320	0.09	0.08	106
January	624	793	956	0.07	0.06	57
February	403	583	577	0.13	0.14	78
March	574	786	768	0.13	0.14	104
April	360	551	562	0.12	0.12	69
May	358	386	461	0.34	0.28	130
June	979	1260	1070	0.14	0.16	175
July	1240	1410	1260	0.11	0.12	154
August	1130	1940	2360	0.09	0.07	167
September	1280	515	617	0.07	0.06	37
TOTAL	10,533	15,564	16,611	0.13	0.12	1956

Table 2a. Cast Net Creel Census Data, summarized by month for fiscal year 1982.

MONTH	Number of Persons	Person- Hours	No. of Gear Units	Gear- Hours	Catch (Kg)
October	48	51	42	43	22
November	43	47	32	35	19
December	56	50	37	37	15
January	32	53	28	49	46
February	21	14	16	11	7
March	55	37	51	35	35
April	65	67	48	52	19
May	48	28	38	21	8
June	55	38	43	30	11
July	68	57	55	44	16
August	81	58	65	51	13
September	39	30	33	26	6
TOTAL	611	530	488	434	220

Table 2b. Cast Net Data, expanded from Table 2a to yield total monthly and annual estimates for FY 1982.

MONTH	Number of Persons	Person- Hours	Gear- Hours	Kg/P-HR	Kg/G-HR	Catch (Kg)
October	288	299	253	0.41	0.48	122
November	352	370	252	0.40	0.59	148
December	423	386	285	0.28	0.37	107
January	252	396	358	0.74	0.82	292
February	184	77	94	0.69	0.56	53
March	364	232	221	1.01	1.06	234
April	502	663	300	0.18	0.39	118
May	492	211	151	0.30	0.42	64
June	389	285	216	0.23	0.31	66
July	500	438	341	0.27	0.35	119
August	553	376	330	0.18	0.20	67
September	314	233	195	0.24	0.28	55
TOTAL	4613	3966	2996	0.41	0.49	1445

Table 3a. Gill Net Creel Census Data, summarized by month for fiscal year 1982.

MONTH	Number of Persons	Person- Hours	No. of Gear Units	Gear- Hours	Catch (Kg)
October	73	124	29	56	71
November	56	76	19	26	63
December	29	18	11	6	17
January	22	10	9	5	6
February	30	11	11	4	4
March	38	24	20	11	23
April	15	28	10	17	5
May	40	75	9	24	22
June	25	54	11	13	19
July	25	36	11	17	10
August	54	133	19	36	25
September	26	77	9	19	4
TOTAL	433	666	168	234	269

Table 3b. Gill Net Data, expanded from Table 3a to yield total monthly and annual estimates for FY 1982.

MONTH	Number of Persons	Person- Hours	Gear- Hours	Kg/P-HR	Kg/G-HR	Catch (Kg)
October	421	761	362	0.61	1.28	463
November	348	393	170	0.91	2.10	357
December	189	108	47	0.76	1.75	83
January	180	91	48	0.66	1.26	60
February	180	53	20	0.40	1.08	21
March	230	158	63	1.13	2.83	179
April	92	196	109	0.14	0.26	28
May	229	505	174	0.26	0.75	131
June	191	544	189	0.32	0.94	177
July	169	275	125	0.28	0.61	77
August	347	778	236	0.17	0.57	136
September	141	352	93	0.06	0.21	20
TOTAL	2717	4214	1636	0.48	1.14	1732

Table 4a. Surround Net Creel Census Data, summarized by month for fiscal year 1982.

MONTH	Number of Persons	Person- Hours	No. of Gear Units	Gear- Hours	Catch (Kg)
October	34	88	4	12	23
November	41	34	7	8	26
December	20	26	4	6	20
January	18	18	2	2	4
February	77	206	7	19	110
March	46	39	6	6	27
April	52	266	6	34	154
May	0	0	0	0	0
June	65	223	10	32	64
July	34	73	6	9	98
August	40	96	6	14	52
September	38	28	4	2	14
TOTAL	465	1097	62	144	592

Table 4b. Surround Net Data, expanded from Table 4a to yield total monthly and annual estimates for FY 1982.

MONTH	Number of Persons	Person- Hours	Gear- Hours	Kg/P-HR	Kg/G-HR	Catch (Kg)
October	170	441	61	0.26	1.90	116
November	246	248	59	0.61	2.58	151
December	106	140	43	0.98	3.18	137
January	99	99	11	0.21	1.92	21
February	376	999	98	0.59	6.03	588
March	104	87	13	0.70	4.82	62
April	258	1330	184	0.59	4.26	785
May	0	0	0	0	0	0
June	400	1300	202	0.30	1.96	395
July	214	448	65	1.23	8.41	550
August	219	541	79	0.65	4.43	351
September	189	148	18	0.55	4.66	82
TOTAL	2381	5781	833	0.56	3.68	3238

Table 5a. Spearfishing Creel Census Data, summarized by month for fiscal year 1982.

MONTH	Number of Persons	Person- Hours	No. of Gear Units	Gear- Hours	Catch (Kg)
October	36	30	36	30	4
November	31	2	31	2	1
December	12	15	12	15	6
January	11	7	11	7	3
February	15	3	15	3	0
March	35	24	31	23	6
April	13	9	13	9	4
May	40	18	37	16	4
June	18	4	16	4	4
July	31	11	29	8	1
August	35	14	37	19	3
September	22	6	21	6	0
TOTAL	299	143	289	142	36

Table 5b. Spearfishing Data, expanded from Table 5a to yield total monthly and annual estimates for FY 1982.

MONTH	Number of Persons	Person- Hours	Gear- Hours	Kg/P-HR	Kg/G-HR	Catch (Kg)
October	206	148	148	0.16	0.16	24
November	230	23	23	0.50	0.50	11
December	60	76	76	0.39	0.39	30
January	60	37	37	0.38	0.38	14
February	92	22	22	0.08	0.08	2
March	190	119	119	0.24	0.24	29
April	106	92	92	0.49	0.49	45
May	292	129	108	0.20	0.24	26
June	128	22	22	0.78	0.78	17
July	224	67	47	0.13	0.19	9
August	222	122	175	0.25	0.18	31
September	195	60	60	0	0	0
TOTAL	2005	917	929	0.30	0.30	238

Table 6a. Gaff and Hook Creel Census Data, summarized by month for fiscal year 1982.

MONTH	Number of Persons	Person- Hours	No. of Gear Units	Gear- Hours	Catch (Kg)
October	24	16	39	28	19
November	38	42	61	69	20
December	1	1	1	1	1
January	1	1	2	2	0
February	10	6	10	5	1
March	3	2	4	2	0
April	38	39	29	59	15
May	27	21	30	24	7
June	55	43	55	58	9
July	30	33	33	35	12
August	20	19	28	53	8
September	19	13	26	23	1
TOTAL	266	236	318	359	93

Table 6b. Gaff and Hook Data, expanded from Table 6a to yield total monthly and annual estimates for FY 1982.

MONTH	Number of Persons	Person- Hours	Gear- Hours	Kg/P-HR	Kg/G-HR	Catch (Kg)
October	150	104	194	1.10	0.59	115
November	301	289	536	0.52	0.28	151
December	10	10	10	0.66	0.66	7
January	6	6	13	0	0	0
February	75	32	34	0.18	0.17	6
March	14	10	11	0.13	0.12	1
April	297	308	449	0.48	0.33	148
May	184	137	552	0.34	0.08	47
June	451	350	499	0.20	0.14	70
July	201	223	232	0.30	0.29	66
August	142	115	327	0.37	0.13	42
September	98	70	116	0.13	0.08	9
TOTAL	1929	1654	2973	0.37	0.24	622

Table 7. Summary of Catch and Effort, by method for fiscal year 1982.

METHOD	Person- Hours	%	Gear- Hours	%	Kg/P-Hr	Kg/G-Hr	Catch (Kg)	%
Hook and Line	15,564	48.5	16,611	63.9	0.13	0.12	1957	21.2
Cast Net	3966	12.4	2996	11.5	0.41	0.49	1445	15.6
Gill Net	4214	13.1	1636	6.3	0.48	1.14	1732	18.8
Surround Net	5781	18.0	833	3.2	0.56	3.68	3238	35.1
Spearfishing	917	2.8	929	3.6	0.30	0.30	238	2.6
Gaff and Hook	1654	5.2	2973	11.4	0.37	0.24	622	6.7
	32,096	100.0	25,978	100.0	0.29	0.36	9232	100.0

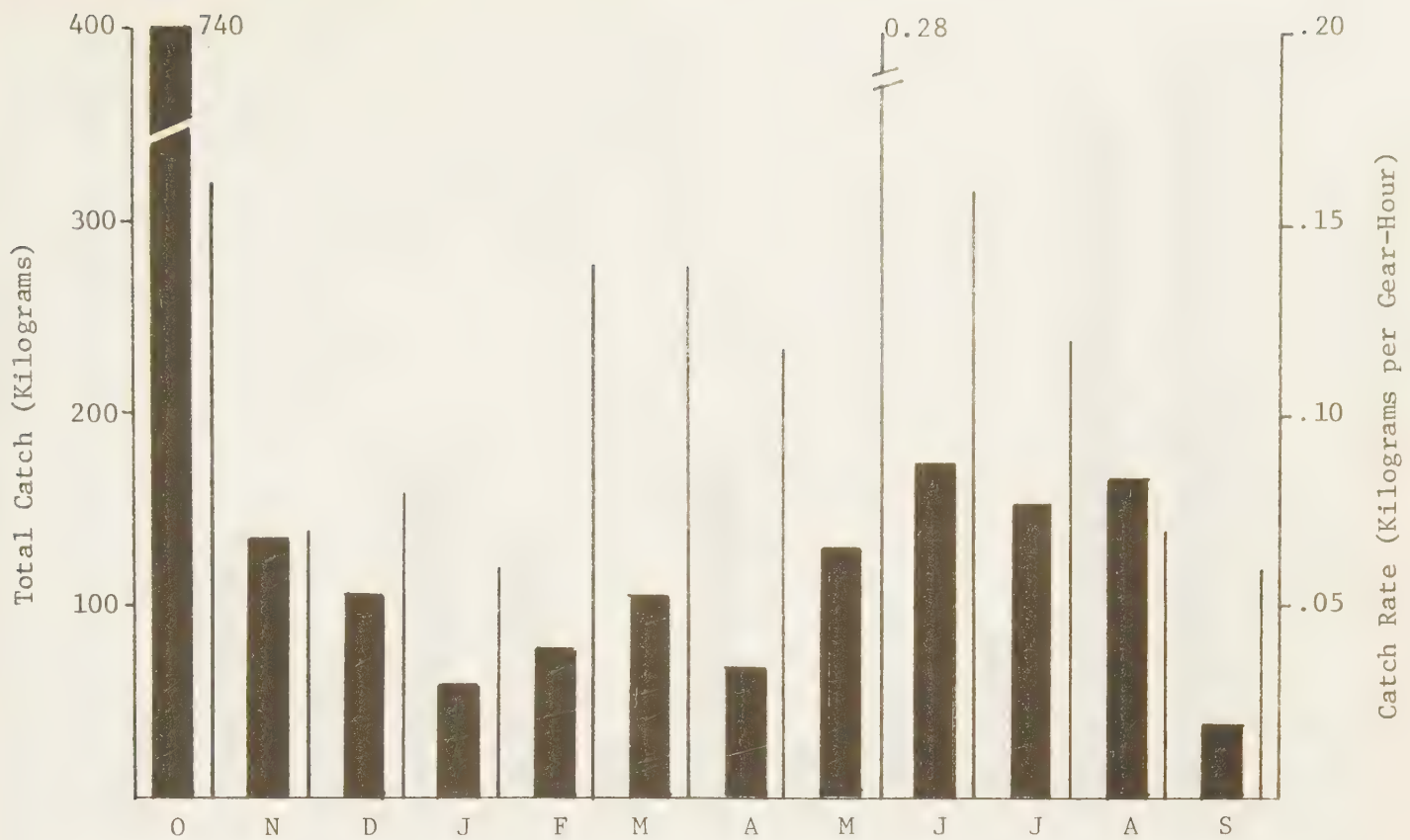


Figure 2. Monthly total catch (kg) and catch rate (kg/gear-hour) for hook and line fishing.

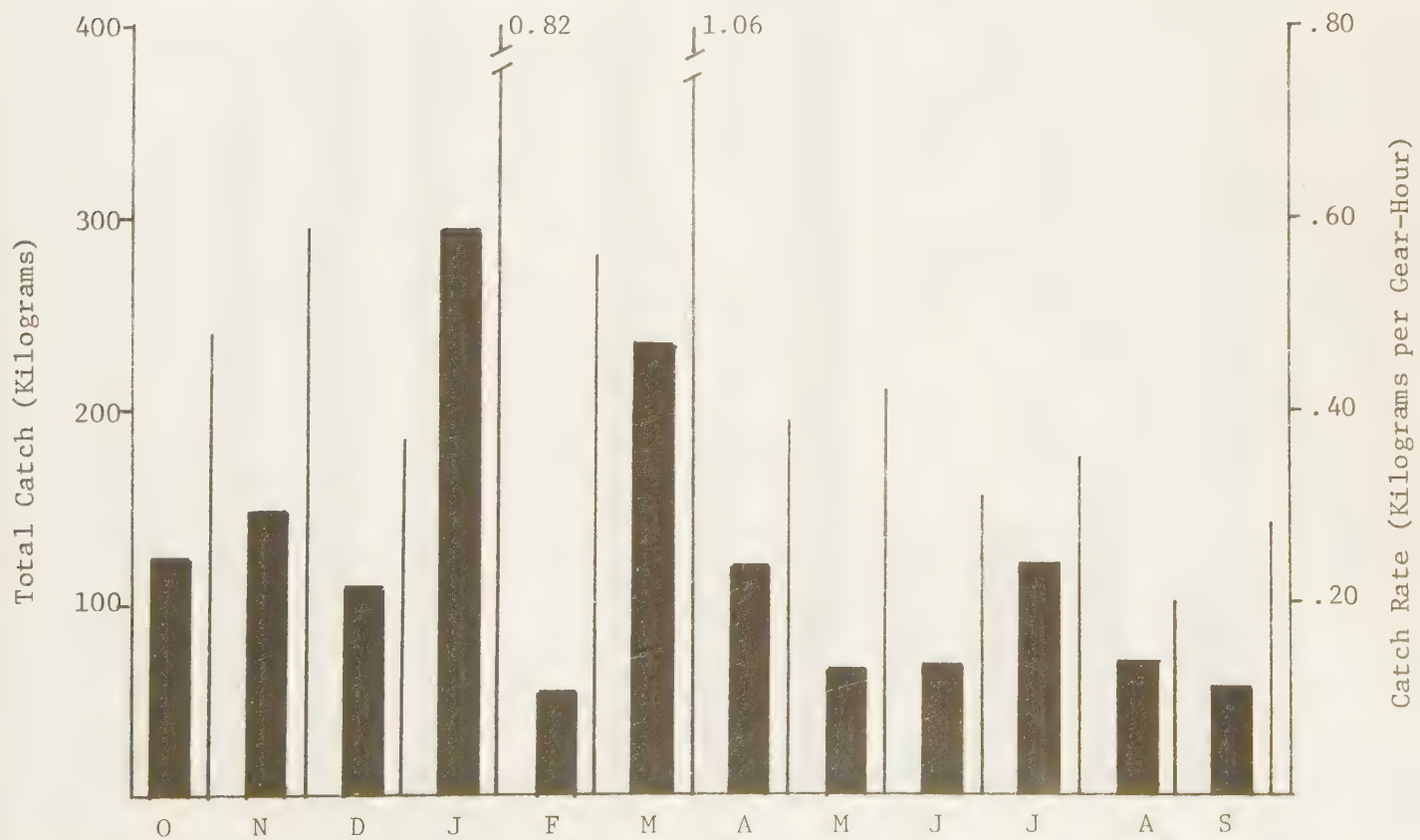


Figure 3. Monthly total catch (kg) and catch rate (kg/gear-hour) for cast net fishing.

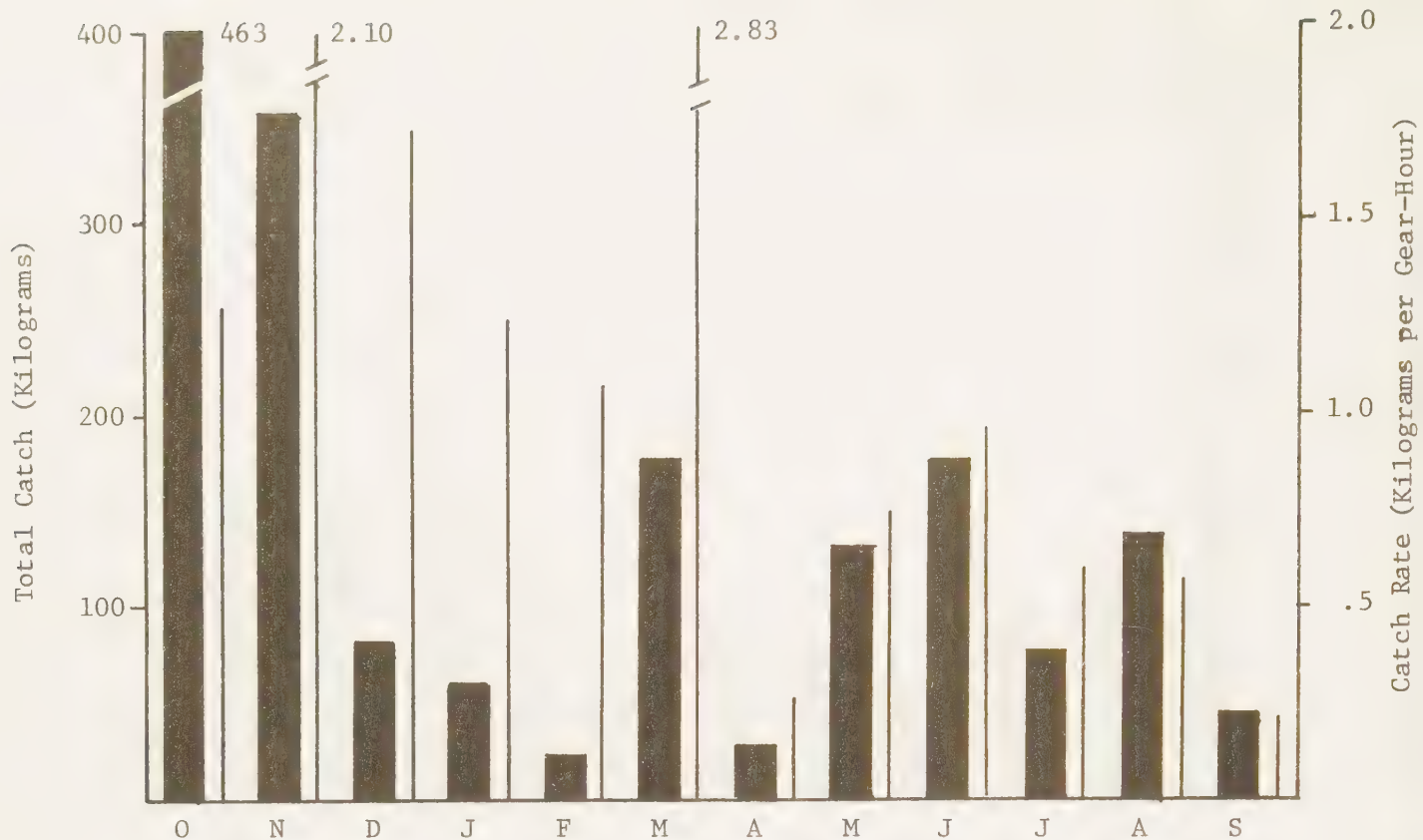


Figure 4. Monthly total catch (kg) and catch rate (kg/gear-hour) for gill net fishing.

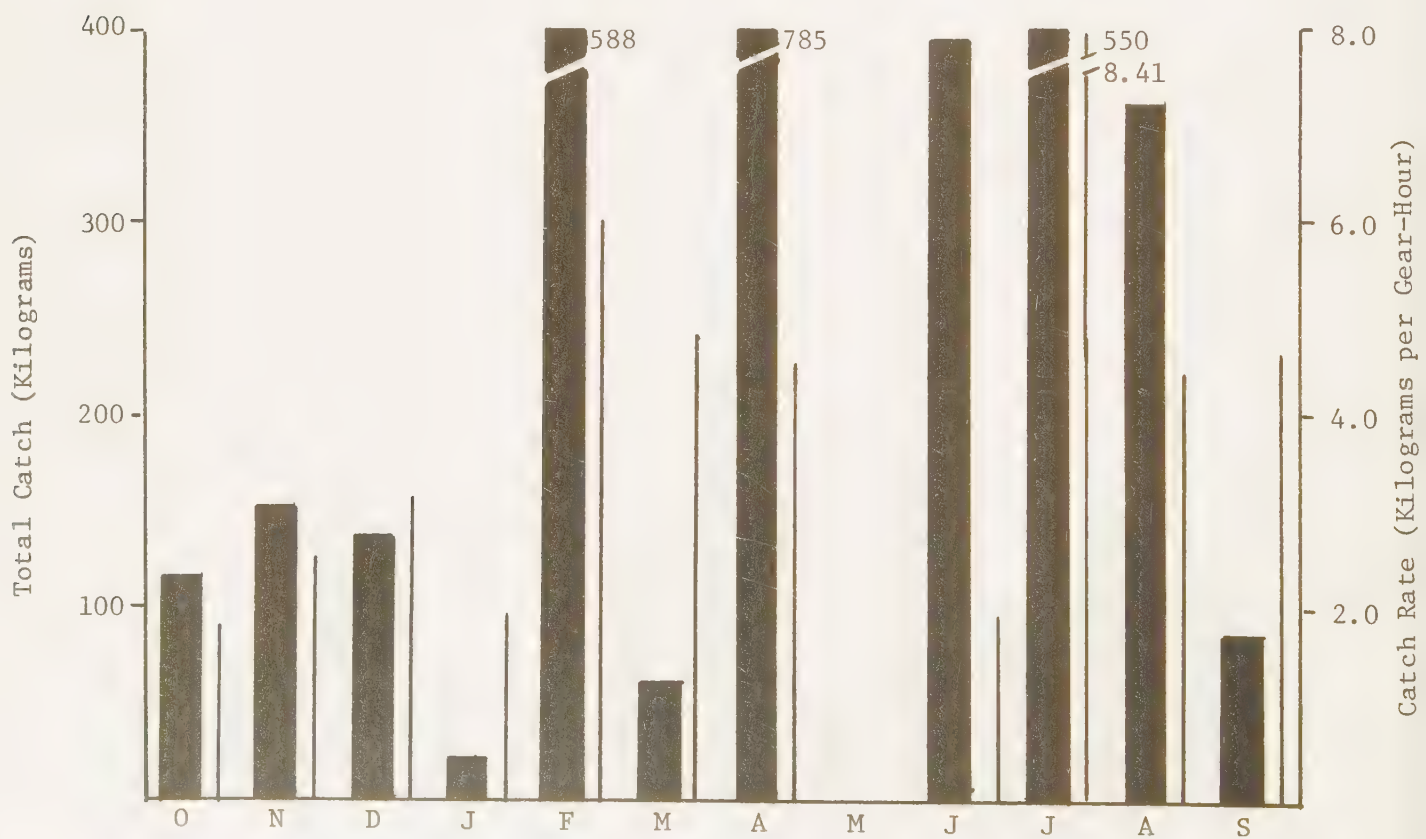


Figure 5. Monthly total catch (kg) and catch rate (kg/gear-hour) for surround net fishing.

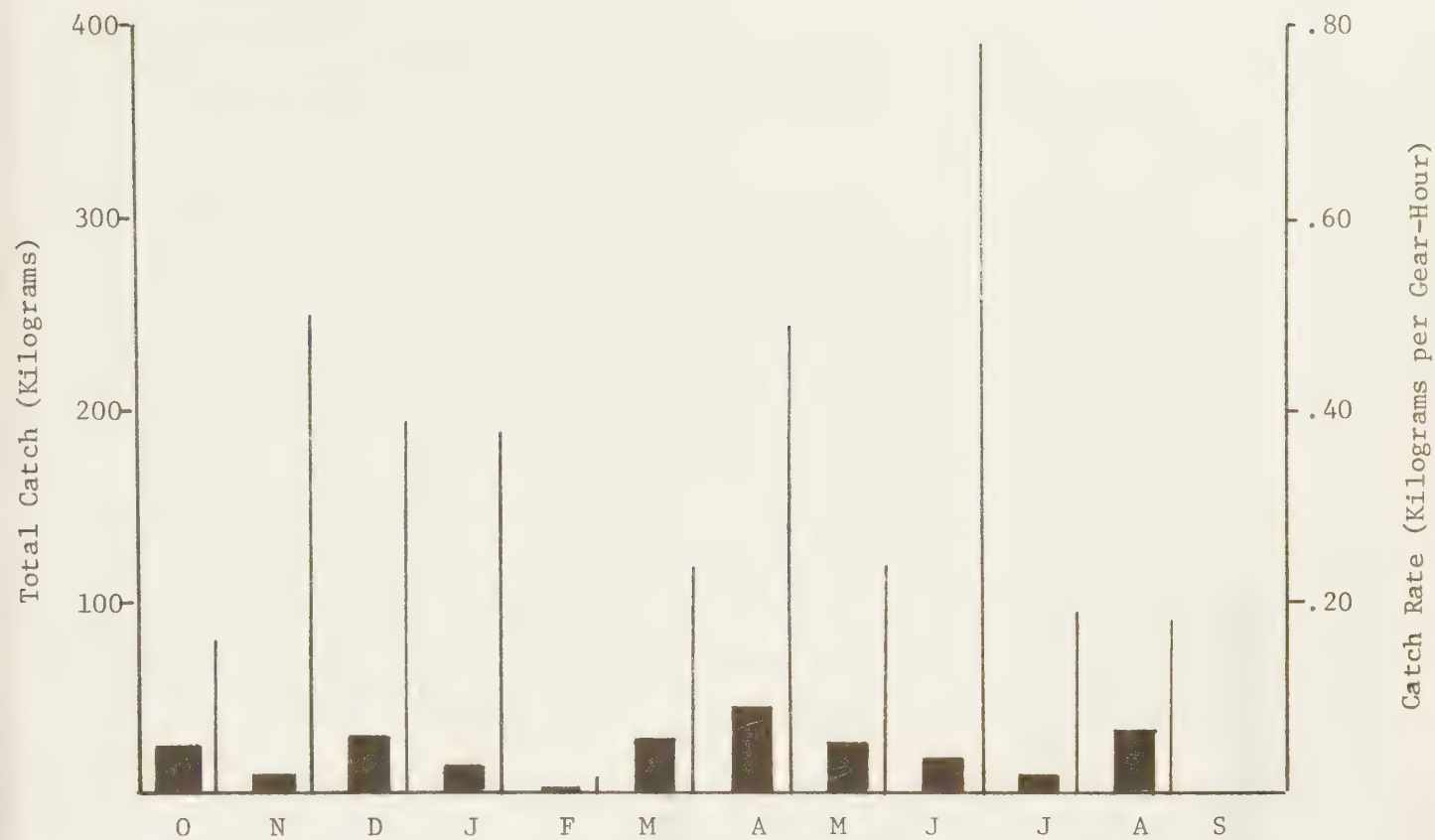


Figure 6. Monthly total catch (kg) and catch rate (kg/gear-hour) for spearfishing.

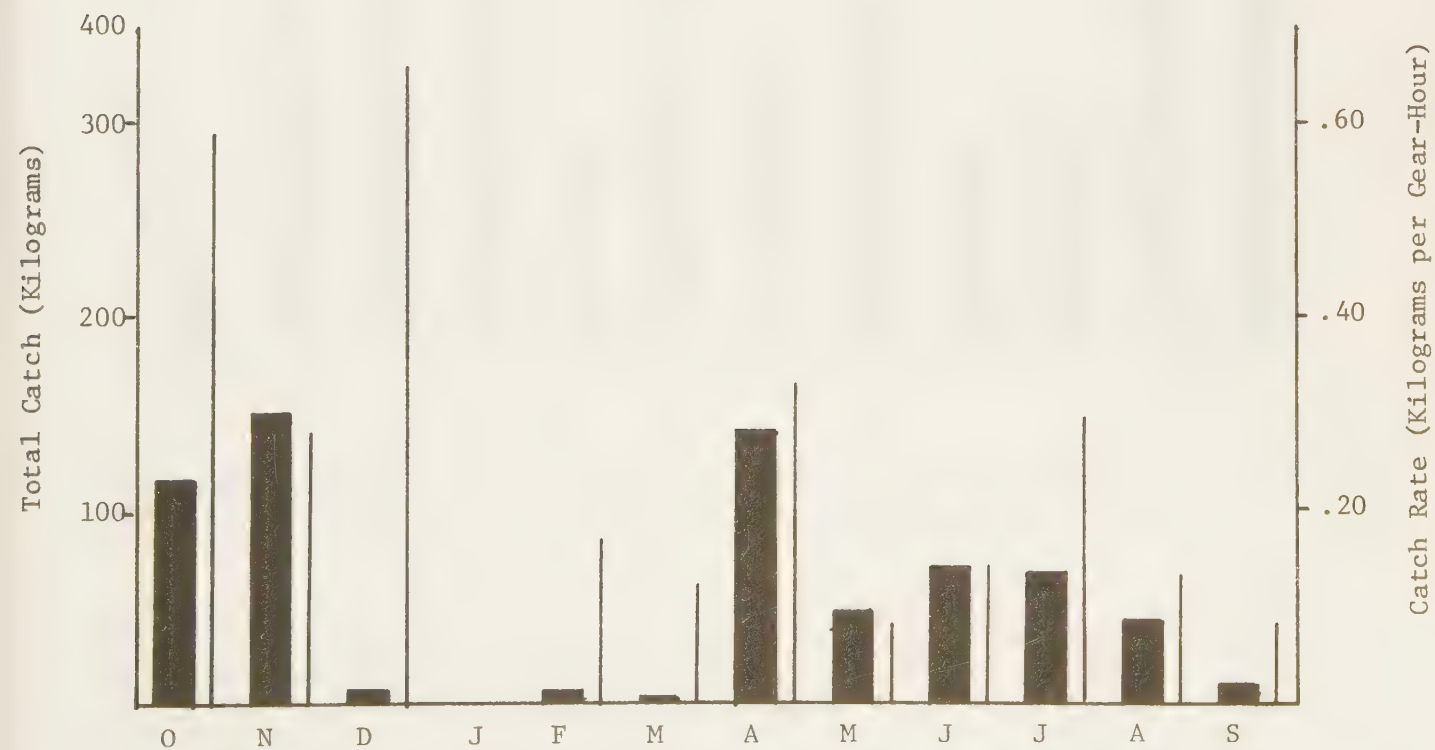


Figure 7. Monthly total catch (kg) and catch rate (kg/gear-hour) for gaff and hook fishing.

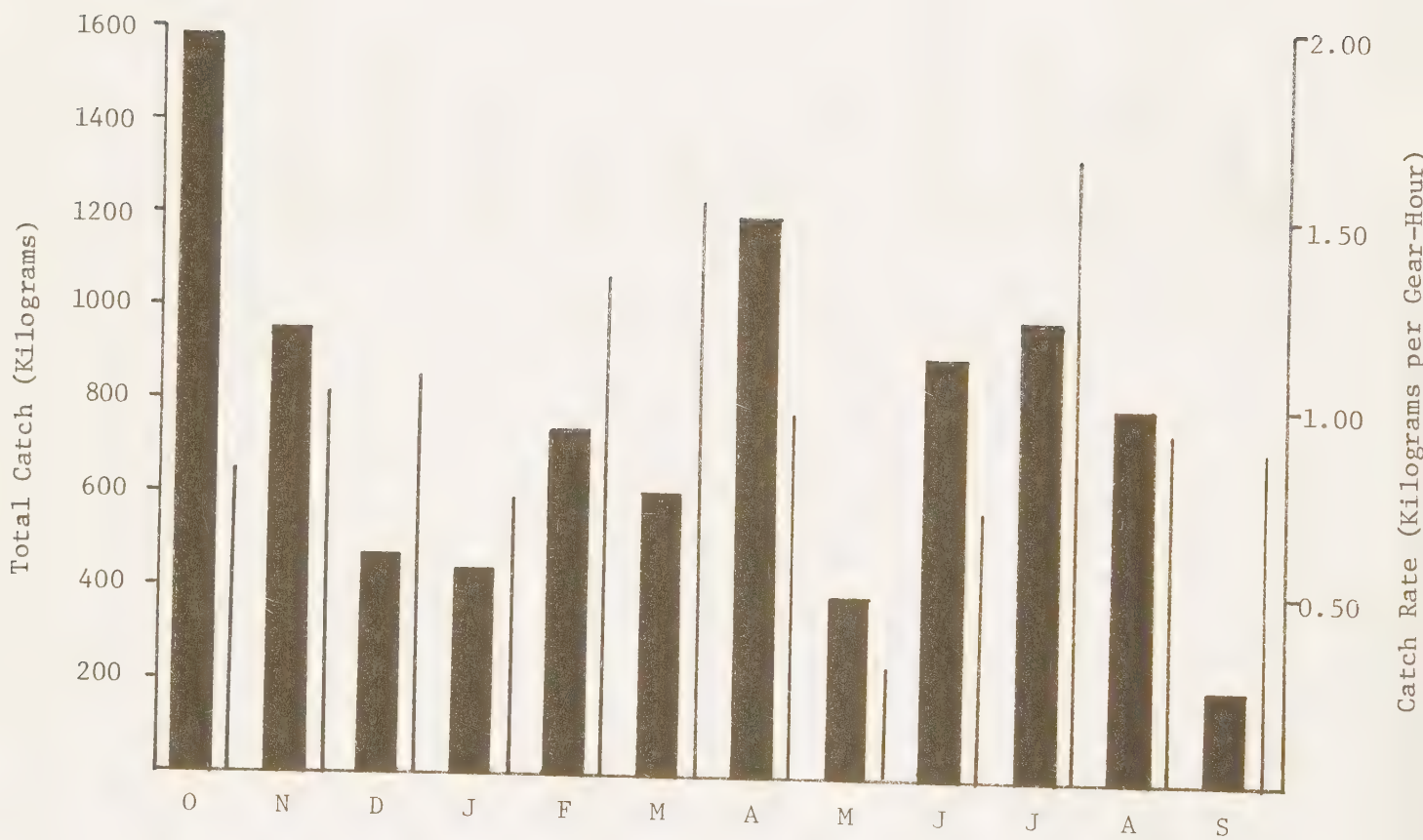


Figure 8. Monthly total catch (kg) and catch rate (kg/gear-hour) for all major fishing methods combined.

respectively. However, because of the nature of participation in the various methods, the order of effort is reversed if gear-hours is considered (i.e. cast netting [11.5%], gill netting [6.3%] and surround netting [3.2%]).

In terms of catch, surround netting was the most productive method, yielding over 35% of the estimated total catch. CPUE values were highest among those for all methods censused, 0.56 kg/person-hr and 3.34 kg/gear-hr. Gill netting produced about 19% of the total catch with CPUE values of 0.48 kg/person-hr and 1.14 kg/gear-hr. Cast net fishing was responsible for over 15% of the yearly take with a corresponding effort of 0.41 kg/person-hr and 0.49 kg/gear-hr. Unlike last fiscal year, net fishing operations did not seem to exhibit any pronounced seasonal patterns, except in the harvest of manahac (juvenile rabbitfish).

The seasonal harvest of juvenile rabbitfish (Siganidae) is anticipated by local fishermen and consequently participation is high. Based on annual catch reports the size of the runs fluctuate greatly from year to year. Although the factors affecting these runs are not clear a possible cause of low-yield years is that the stocks are being overharvested. During the manahac runs, juveniles come over the reef in large, concentrated masses, allowing fishermen to net a large percentage of the individuals recruiting to a given area. This form of highly intense fishing effort may result in the serious reduction of a whole year's recruitment stock.

In contrast to last year's heavy manahac runs, most 1982 runs were light. Sporadic runs occurred in April and May around the last quarter moon. The largest run occurred on May 16 in the area from Gadao to Manell Channel. An estimated 200-300 kg of manahac were harvested. A concurrent run at Ipao Beach produced approximately 50 kg. The total estimated manahac harvest for 1982 was less than 500 kg as compared to the 1981 harvest that was estimated at 4,158 kg.

Spearfishing is the most difficult inshore fishing method to census. Spear fishermen are often invisible and inaccessible to interviewers and the most productive fishing hours are after dark when no creel census interviews are conducted. For this reason, we consider our spearfishing estimates to be very conservative. The data show that spearfishing activity was lowest in terms of person-hours expended (about 3% of the total yearly fishing effort) and slightly higher only than gill netting in terms of gear-hours (3.6%), producing 2.6% of the total catch from a CPUE of 0.30 kg/person-hour. We emphasize that these are low estimates for the reasons stated above.

In addition, 266 persons were censused while collecting 93.2 kg of octopi from the reef flats. From these data it was estimated that 1654 person-hours of harvesting yielded 622 kg of octopi during FY 1982. This results in a CPUE value of 0.37 kg/person-hour.

An estimated 443 persons were censused using "other" methods. "Other" methods are defined as any method that was censused secondarily to one of the six major inshore fishing methods. "Other" methods also include the hand-harvesting of mollusks and echinoderms. In FY 1982, 177 persons were interviewed while harvesting shellfish, primarily the clam, Gafrarium tumidum and the topshell, Trochus niloticus. These people harvested an estimated 325 kg in 221 hours, yielding total estimates of 4730 kg harvested in 3220 person-hours (CPUE = 1.5 kg/person-hour).

RECOMMENDATIONS

Guam is currently participating in a regionwide program of reviewing and analyzing past creel census data for incorporation into the Fisheries Information Network (FIN). A draft framework plan for a Fishery Data Collection System (FDCS) for Guam is being prepared for the National Marine Fisheries Service (NMFS) by a consultant from CIC Research, Inc. In its final form, the report will make recommendations concerning the improvement and standardization of data collection procedures. This report will be given serious consideration and the appropriate recommendations will be incorporated into our existing data collection program.

Report prepared by: Deborah A. Grosenbaugh



PROJECT TITLE: Fish Weir Report

PERIOD COVERED: October 1, 1981 to September 30, 1982

Permits for six fish weir sites in the Merizo/Cocos Lagoon region were granted for FY 82 (Fig.). A total catch of 4,439.7 kg of fish was reported in 61 monthly catch reports. All of the missing reports were found to correspond with months when the weir in question was not in operation due to either storm damage or neglect by the operator. This made expansion of the data unnecessary and greatly increased the degree of accuracy of the FY 82 harvest figure over that of previous years.

Average daily catch rates for a given month fluctuated widely at each site, ranging between 1.03 kg/day and 11.45 kg/day (Table 1). The mean daily catch rate for FY 82 ranged from a low of 2.04 kg/day at site 6 to a high of 7.11 kg/day at site 4. The average mean daily catch rate for all six sites was 4.68 kg/day, while the mean daily catch rate for all sites combined (taking into account difference in operating time at each site) was 4.70 kg/day. The six sites operated an average of 157.5 days each, or 43.2% of the time during FY 82. Site 2 was operational the greatest number of days (283).

The major reasons given for inoperability of the sites were damage due to high surf or strong currents. Neglect due to employment commitments was a reason given by an operator on one occasion. Poaching was reported as a reason for some of the no-catch days.

The reported catch and its composition by weight is presented in Table 2. This year's catch composition was very similar to that of FY 81. The dominant families were the Lethrinidae* (20.6%), Carangidae (19.5%), Mullidae (17.4%) and Mugilidae (10.7%).

The annual fish weir harvest has declined during each of the last three years. The FY 82 total reported harvest represents a decrease of 47.2% from the total estimated harvest of 8,431 kg for FY 80. The elimination of one of the seven sites authorized during FY 80 accounts for part of this decline. Over-estimation of catches not reported during FY 80 and FY 81 might account for a significant portion of the differences in harvest between these years and FY 82.

Report prepared by: Robert F. Myers

*Although the family Lutjanidae is listed in the FY 81 report, the name "mafute", is utilized on the catch reports. This local name more appropriately refers to several species of lethrinids, but it is likely that certain lutjanids as well as lethrinids are reported "mafute" by the weir operators.

Table 2. Reported fish wier harvest and composition for FY82.

Fish Family	Reported catch (Kg)	Percent (%) of Total catch
Acanthuridae (Surgeonfishes, Kicho)	24.7	0.6
Carangidae *		
(Jacks, Tarakito)	867.1	19.5
Carangidae <u>S. crumenophthalmus</u> (Atulai)	2.7	<0.1
Leiognathidae (Soapys, Guaguas)	331.5	7.5
Lethrinidae ** (Emperors, Mafute)	916.0	20.6
Mugilidae (Mulletts, Laiguan)	473.0	10.7
Mullidae (Goatfishes, Salmoneti)	772.3	17.4
Serranidae (Groupers, Gadao)	94.8	2.1
Siganidae (Rabbit fishes, Sesjun)	144.2	3.2
Others	812.7	18.3
Total (12 mo.)	4,439.7	100.0

* excluding Selar crumenophthalmus

** listed as Lutjanidae (Snappers) in the FY-81 report.

Table 1. Average daily catch rates, (kg/day in operation) for the licensed fish wiers operating in the Merizo/Cocos Lagoon region during FY-82.

Site #	Location	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	FY-82	No. of days in Operation
1	Tamogi-Afgo	3.41	3.42	3.15	5.15	4.92	6.06	8.00	6.51	10.33	9.02	-	-	5.73	283
2	Hasta-Sagua Dano	-	-	-	-	7.38	5.28	-	-	3.88	11.45	3.09	6.09	6.13	101
3	Aguan-Acho Dekiki	-	6.18	1.18	5.25	3.55	3.09	-	-	-	10.25	-	-	4.03	133
4	Sagua Usao-Ton Vicente	-	-	5.79	9.06	5.75	7.71	-	-	-	-	-	-	7.11	121
5	Aba-Aang	8.26	2.97	3.29	3.49	2.49	3.61	2.57	1.03	2.49	3.59	3.08	-	3.04	179
6	Sagua Usao-Mapua	-	4.31	3.40	1.81	3.98	1.68	1.47	2.32	1.40	-	-	-	2.04	128
All Sites *		5.84	4.22	3.36	4.95	4.68	4.57	4.01	3.28	4.53	10.24	3.79	6.09	4.68	157.5

* Means for all sites combined are based on an average of each site's monthly mean.

The mean daily catch rate for all six sites combined, taking into account differences in operating time between sites was 4.70 kg/day.

PROJECT TITLE: FISHERIES INFORMATION RELATED TO THE MERIZO/COCOS
LAGOON REGION

Introduction

The Division of Aquatic & Wildlife Resources (DAWR) has been monitoring fishing activities within the Merizo/Cocos Lagoon region for several years. Data for this region have been collected through various means. These include monthly fish weir catch reports, monthly inshore and offshore creel censuses, and an aerial fisheries survey program. This report summarizes the data collected through each of these means and provides estimates of average annual participation, effort and catch for fishing in the region, which should be regarded as minimums.

FISH WEIRS

From FY 64 through FY 76 there were 12 licensed fish weir sites located within the Merizo/Cocos Lagoon region. During fiscal years 77, 78 and 79 that number dropped to nine, eight and seven, respectively. Since FY 81 there have been six licensed weirs operating within the region (Figure 1). This reduction is in line with the established Department of Agriculture policy of licensing existing weir sites only, not opening any new or additional sites, and permanently closing sites that are not renewed in any one year. Although the operators of fish weirs on Guam are required to submit monthly catch reports to our office, in the past much of this information has not reached us. However, cooperation in this regard has increased in recent years. Based on data that have been submitted, we can at this time provide some average monthly catch rates for the weirs that are currently licensed.

Table 1 presents this data in summary form for the fiscal years since FY 75. Prior to that year the data are very incomplete. A seventh site, which is now closed, is also listed in the table. A comparison of the mean catch rates for each weir site indicates that Site #1 near the steep walls at the mouth of Mamaon Channel is the most productive. The weirs near the southern barrier reef appear to be relatively intermediate in productivity (Sites #2, 6 and 7), while those located further into the lagoon or near the alluvial coastal lowland of Guam (Sites #3, 4 and 5) show the lowest catch rates. Site #5 is the least productive, which is probably the result of the relatively depauperate condition of the reef fish community common in the sandy/silty regions of the lagoon.

The calculated average catch rate for all seven sites during the seven year period is approximately 76 kg/mo. Maintenance and down time are accounted for within this figure. If this average rate is applied to the six currently licensed fish weirs, less 10% for additional down time and repairs, we would estimate the average annual fish weir harvest for the whole lagoon to be around 4925 kg. The catch from these weirs consists of many species belonging to several families, the most prominent being Carangidae (jack), Lutjanidae (snappers), Mullidae (goatfishes), Leiognathidae (soapys) and Siganidae (rabbitfishes). In the past, large catches of the seasonal jack, Selar crumenophthalmus, known locally as

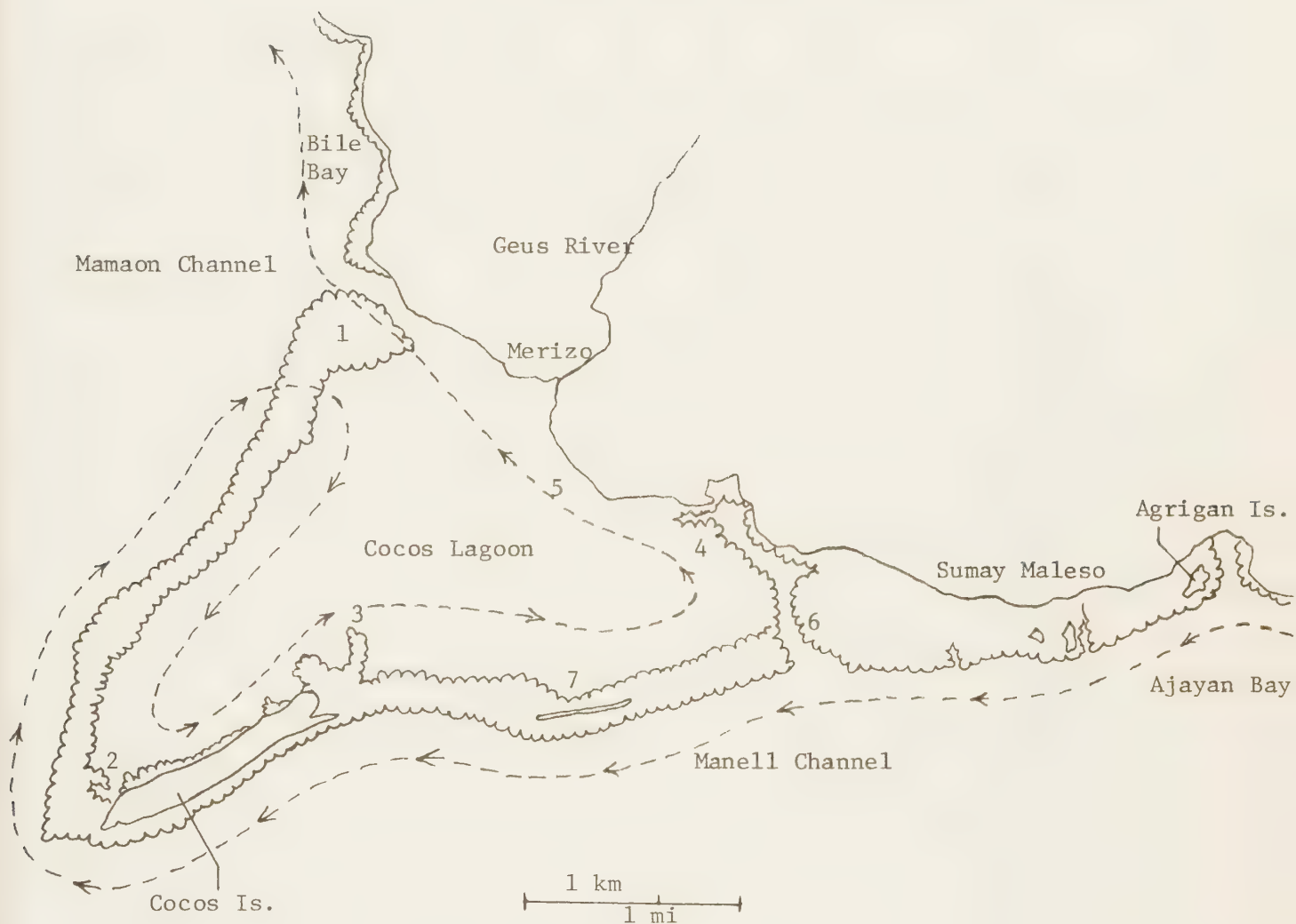


Figure 1. The Merizo/Cocos Lagoon aerial survey region showing the general survey route. The numbers indicate the locations of licensed fish weir sites. See text for explanations.

Table 1. Monthly catch rates for the licensed fish weirs operating in the Merizo/Cocos Lagoon region since FY'1975. Numbers in parentheses represent the number of monthly reports submitted by the weir operators. FY'79 was a 15-month year. Only the first six sites are currently licensed. The seventh site was closed after FY'1980.

SITE #	LOCATION	FY'75	FY'76	FY'77	FY'78	FY'79	FY'80	FY'81	MEAN
1	TOMOGI-AFGO kg/mo.				352 (4)	98 (14)	172 (9)	124 (12)	186
2	HASTA-SAGUA DANO								
3	AAGUAN-ACHO DEIKI kg/mo.	60 (3)	27 (10)	0 (3)		96 (9)	175 (6)	61 (8)	66
4	SAGUA USAO-TON VICENTE kg/mo.			34 (6)	36 (6)	81 (11)	41 (12)	54 (10)	49
5	ABA-AAANG kg/mo.			54 (3)	28 (2)		15 (11)	18 (9)	29
6	SAGUA USAO-MAPUA kg/mo.			34 (1)	124 (8)	68 (10)	47 (8)		68
7	ACHO DEIKI-FANDISKAN- SAJAN BABI kg/mo.	158 (9)		99 (9)	43 (3)	27 (4)	82 (3)		82

atulai, have also been reported. These catches are usually most frequent during the late summer and fall months, however, in recent years the number of reports from Cocos Lagoon has decreased. Some local fishermen feel very strongly that increased boat traffic in the lagoon has kept the atulai away.

INSHORE CREEL CENSUS

Inshore fishing activities on Guam are monitored through regularly scheduled monthly creel censuses. These censuses are made over most of Guam's readily accessible coastline, including the Merizo/Cocos Lagoon region. The objective of this program is to assess the major inshore fishing methods in terms of their popularity and success on an island-wide basis.

Methods

From FY 77 through FY 81, a total of 113 censuses were conducted in the Merizo/Cocos Lagoon region. A nearly equal weekday/holiday (including weekends) distribution was attained (56 W censuses; 57 H censuses). The data presented here were gathered within the area encompassed by Bile Bay to the north, Merizo to the south, and Agrigan Island to the east (Fig. 1). During a census day, fishermen were intercepted by a biologist on foot, and interviewed anywhere from the shoreline out to the reef margin. However, due to its relative isolation, complexity and large area the Merizo/Cocos Lagoon region is a difficult one to census adequately from shore.

The vast majority of the fishing activities that occur out in the lagoon proper and on the barrier reefs and associated islands are not sampled. Since our biologists must move on foot they are limited to sampling the activities that occur near shore and on the fringing reef flats. The problem is compounded further because this shoreline is largely covered by silty mud and much of it is separated from Route 4 by mangrove and other thick vegetation. As a result, the fishing activities that take place along this stretch of shoreline are not adequately sampled. In addition, we are totally lacking hard data on nighttime fishing activities which we know to be very important. For these reasons, we feel that the inshore creel data for the region are incomplete and underrepresentative of the fishing activities that occur there, but may be used to estimate minimum levels of participation, effort and catch.

The following formula were applied to the inshore creel census data in order to derive average annual estimates of participation, effort and catch:

Participation

$$P/yr = [(P_{wc} \times T_w) \times 196] + [(P_{hc} \times T_h) \times 96]$$

$$T/yr = \left[\frac{(P_{wc} \times T_w) \times 196}{P_{wt}} \right] + \left[\frac{(P_{hc} \times T_h) \times 96}{P_{ht}} \right]$$

Effort

$$P-H/yr = \left[\frac{(P_{wc} \times T_w) \times 196}{P_{wt}} \right] P-H_{wt} + \left[\frac{(P_{hc} \times T_h) \times 96}{P_{ht}} \right] P-H_{ht}$$

$$G-H/yr = \left[\frac{(P_{wc} \times T_w) \times 196}{P_{wt}} \right] G-H_{wt} + \left[\frac{(P_{hc} \times T_h) \times 96}{P_{ht}} \right] G-H_{ht}$$

Catch

$$Kg/yr = \left(\left[\frac{(P_{wc} \times T_w) \times 196}{P_{wt}} \right] G-H_{wt} + \left[\frac{(P_{hc} \times T_h) \times 96}{P_{ht}} \right] G-H_{ht} \right) Kg/G-H$$

Where P/yr is the estimated number of persons per year,

T/yr is the the estimated number of fishing trips per year,

T_w is the mean number of fishing trips per weekday and is calculated by the formula:

$$T_w = \frac{12 \text{ daytime hours}}{\bar{x} \text{ number hours per weekday trip,}}$$

T_h is the mean number of fishing trips per holiday (including weekends) and is calculated similar to T_w ,

P_{wc} is the mean number of persons seen per weekday census,

P_{hc} is the mean number of person seen per holiday census.

196 is the number of fishable weekdays per year and is subjectively calculated by the formula:

$$196 = (365 \text{ days/yr} \times 0.67) \times 0.80,$$

96 is the number of fishable holidays per year and is subjectively calculated by the formula:

$$96 = (365 \text{ days/yr} \times 0.33) \times 0.80,$$

P_{wt} is the mean number of persons censused per weekday fishing trip,

P_{ht} is the mean number of persons censused per holiday fishing trip,

P-H/yr is the estimated number of person-hours per year,

$P-H_{wt}$ is the mean number of person-hours per weekday fishing trip,

$P-H_{ht}$ is the mean number of person-hours per holiday fishing trip,

G-H/yr is the estimated number of gear-hours per year,

$G-H_{wt}$ is the mean number of gear-hours per weekday fishing trip,

$G-H_{ht}$ is the mean number of gear-hours per holiday fishing trip, and

Kg/G-H is the mean catch per unit effort value in kilograms of fish per gear-hour.

Results & Explanations

The inshore creel census data were compiled for five primary fishing methods and an "other" methods category which is mostly representative of octopus hunting and the collecting of gastropods and bivalves. Table 2 compares actual weekday and holiday rates of participation and effort on a per trip basis, and gives a calculated rate of catch per gear-hour for each method category. Computed average annual estimates of participation, effort and catch (Table 3) show gill netting to be the most popular inshore method in terms of the number of persons, the number of trips and the amount of person-hours expended. In contrast, surround netting is the most productive method, contributing 54% of an estimated average annual daytime catch of 4565 kg.

Although we do not have data on nighttime fishing activities, we do know that spearfishing is by far the most important method employed in the lagoon at night. We have been informed by the Merizo Commissioner, Mr. Joe Tyquiengco, that an average of five spearfishermen per night is a reasonable minimum estimate of nighttime participation for that method. According to Mr. Tyquiengco, and other resident spearfishermen, the average nighttime spearing trip lasts around four hours and results in a catch rate of 0.6 kg/gear-hr or twice that calculated for daytime spearing. In general, these figures seem to be reasonable minimum estimates. If these data are applied to a year in which 80% of the nights are fishable, an estimated annual nighttime spearfishing harvest of 3504 kg would result from 5840 person-hours of effort. Thus, based on our inshore creel census data an estimated average inshore harvest for the region attributed to the fishing methods listed in Table 3 is approximately 8069 kg/yr.

In addition to this the Merizo/Cocos lagoon region usually experiences seasonal runs of juvenile rabbitfishes (manahac) of the species Siganus spinus and S. argenteus. These runs are typically sporadic over a few-day period around the last quarter moon and may occur during the months of April, May, June, September and/or October. The magnitude of these runs are highly variable from year to year. Annual catch estimates for the region have ranged from less than a hundred to several thousand kilograms per season.

OFFSHORE CREEL CENSUS

The offshore creel census program was initiated in Merizo during FY 79. The level of census effort has been light since that time due to limitations in personnel and job priorities. However, some general information regarding offshore fishing in the region may be useful. The objective of this program is to monitor the monthly offshore catch in order to estimate

annual participation, effort and catch for trolling, bottomfishing and offshore spearing.

Methods

When the offshore census began in Merizo it was done quarterly on one weekday and one holiday (including weekends). By FY 81 the level of census effort was increased to twice per month. Between FY 79 and 81, 38 censuses had been conducted. During these censuses all fishing parties either launching or landing were interviewed and their catch was censused. Based on these interviews general information on participation, effort and catch may be calculated only for the method of trolling.

Results & Explanations

Table 4 summarizes the offshore creel census data recorded from FY 79 through FY 81. Our creel censuses show a mean of 1.6 boat trips/day out of Merizo but from additional surveys we know that we are censusing only about half of actual offshore effort. A recent survey sets the average number of boat trips per weekday at around 3. The number of boat trips per holiday is around 8. If we assume only 80% of the year is fishable offshore, we would estimate approximately 45 weekday trips and 48 holiday trips per month. This total of 93 trips/mo or about 3.1 trips/day is almost twice our censused effort. Therefore, at 3.2 trips/day (2×1.6 trips/day) we estimate approximately 934 trips/yr, involving 2897 persons, to account for an estimated average annual trolling catch of 17,286 kg.

AERIAL FISHERIES SURVEYS

The aerial fisheries survey program was started in FY 61 as a means of acquiring fisheries-related information that would supplement data obtained from inshore creel censuses. Although the flights covered the whole island, the data presented here are for the Merizo/Cocos Lagoon region only. The objective of this program was to obtain a series of roughly "instantaneous" assessments of Guam's island-wide inshore fishing activities. Limited data on offshore fishing activities were also taken. The gathering of information on the presence of turtles, porpoise and sharks in the nearshore surface waters around Guam was of secondary importance. Data on inshore nonfishing activities were also compiled especially in later years. Certain points outlined in the Methods section should also be kept in mind when interpreting the data.

Methods

All of the survey flights took place roughly during the late morning hours of the day. None of the flights began earlier than 0900 hrs. or lasted later than 1300 hrs. The average length of flight per survey was approximately 1.5 hrs. Throughout the entire program a schedule of one holiday (including weekends) and one weekday flight per survey month was attempted. The same general route was followed during each flight. The Merizo/Cocos Lagoon region was always surveyed during the first third of each flight and was consistently approached from the northeast. The approximate survey route for this region is shown in Figure 1. This region is bounded on the north by the mouth of Mamaon Channel, includes all of the

Table 2. Actual weekday (w) and holiday (H) rates of participation, effort and catch for inshore fishing within the Merizo/Cocos Lagoon region based on inshore creel census data.
 * = based on island-wide data from FY 79-81.

	#Persons Per Trip		#Gear Per Trip		#Hours Per Trip		#Gear Per Pers.		#Kg Per Gear-Hr
	W	H	W	H	W	H	W	H	
Hook & Line	1.4	2.2	1.3	2.2	2.6	3.6	0.9	1.0	0.2
Cast Net	1.6	1.8	1.5	1.8	2.8	2.4	1.0	1.0	0.4
Gill Net	2.5	2.5	1.0	1.0	3.0	4.8	0.4	0.4	0.7
Surround Net	5.3*	6.5	1.0	1.0	4.1*	4.2	0.2	0.1	5.2
Spear	3.2	3.0	3.2	3.0	3.3	2.6	1.0	1.0	0.3
Other Methods	3.3	1.0	3.3	1.0	3.0	1.6	1.0	1.0	0.4
TOTAL									

Table 3. Estimated annual participation, effort and catch for inshore fishing in the Merizo/Cocos Lagoon region based on inshore creel census data.

Fishing Method	Est. #Pers. Per Year	Est. #Trips Per Year	Est. #Pers-Hrs. Per Year	Est. #Gear-Hrs. Per Year	Est. #Kg Per Year
Hook & Line	434	244	1408	1370	274
Cast Net	673	397	1680	1660	664
Gill Net	1000	400	3240	1356	949
Surround Net	684	113	3186	471	2448
Spear	521	169	1787	486	146
Other	192	82	541	198	85
TOTAL	3504	1405	11842	5541	4565

Table 4. Rates and Annual Estimates of Participation, Effort and Catch for Offshore Fishing Out of Merizo.

	#Persons Per Trip	#Kg Per Trip	#Trips Per Day (Creel)	#Trips Per Day (Actual)	Est #Trips Per Year	Est #Pers Per Year	Est #Kg Per Year
FY 1979	2.3	44.2	1.7	3.4			
FY 1980	3.2	10.7	1.5	3.0			
FY 1981	3.4	16.0	1.8	3.6			
MEAN	3.1	18.5	1.6	3.2	934	2,897	17,286

Merizo shoreline, the barrier reef/Cocos Island complex, the entire lagoon, Mannel Channel, the Sumay Malesso area east to Ajayan Bay and the offshore waters just outside of the reef.

From FY 63 through the first half of FY 66 a U.S. Navy helicopter was used on all flights. A single engine light aircraft was used on the remaining flights. In addition, the pilots on these flights changed periodically. These changes resulted in a certain amount of flight-to-flight variation in average speed and altitude which were not always recorded. However, the earlier flights were probably made at lower altitudes, eg., 200 feet during FY 67, than the later flights, eg., 800 feet during FY 78 and 79. There were also observer changes made over the years. In all, four different biologist were responsible for the data collected during this program.

Although an equal weekday/holiday distribution of flights was attempted the data collected during this program was reported in a format that did not make this distinction. Thus, for each major inshore fishing method average annual estimates of participation, effort and catch based on these data, and supplemental data from the inshore creel census, were derived using the following formulae:

Participation

$$P/yr = (P_f \times T_d) \times D_f$$

$$T/yr = \frac{(P_f \times T_d) \times D_f}{P_t}$$

Effort

$$P-H/yr = \frac{(P_f \times T_d)}{P_t} \times P-H$$

$$G-H/yr = \frac{(P_f \times T_d)}{P_t} \times G-H$$

Catch

$$\# \text{ Kg/yr} = \left[\frac{(P_f \times T_d) \times D_f}{P_t} \times G-H_t \right] \text{ Kg/G-H}$$

Where P/yr is the estimated number of persons per year,

T/yr is the estimated number of fishing trips per year,

T_d is the mean number of fishing trips per day (weekdays and holidays) and is calculated by the formula:

$$T_d = \frac{12 \text{ daytime hours}}{\bar{x} \text{ number hours per trip,}}$$

D_f is the number of fishable days per year (weekdays and holidays) and is subjectively calculated by the formula:

$$D_f = 365 \text{ days per year} \times 0.8,$$

P_f is the mean number of persons seen per survey flight (weekdays and holidays),

P_t is the mean number of persons per fishing trip (weekends and holidays) based on the inshore creel census data,

P-H/yr is the estimated number of person-hours per year,

$P-H_t$ is the mean number of person-hours per fishing trip (weekdays and holidays) based on the inshore creel census data,

G-H/yr is the estimated numbers of gear-hours per year,

$G-H_t$ is the mean number of gear-hours per fishing trip (weekdays and holidays) based on the inshore creel census data, and

Kg/G-H is the mean catch per unit effort value in kilograms of fish per gear-hour.

Results & Explanations

Table 5 presents a summary schedule of survey flights made during the program between FY 63 and FY 79. Yearly and monthly gaps in the schedule were the result of a variety of causes such as changes in personnel, budgetary and supply problems, pilot and aircraft unreliability, storms, emergencies etc. Yet, of the 168 flights that were made a nearly equal weekday/holiday distribution was attained.

Table 6 is a summary of the data recorded in the Merizo/Cocos Lagoon region during the fiscal years indicated. The numbers given under "Inshore Fishing" represent the numbers of people that were observed using a particular inshore fishing method. The number given under the other headings are self-explanatory. Asterisks in this table indicate that for these fiscal years, individuals falling in certain categories were not counted. During FY 78 and 79 running tour boats in the lagoon were counted. The picnickers listed under FY 78 and 79 were those visible primarily on Cocos Island including its adjacent sandbar.

Based on the actual raw data (Table 6) the most popular methods of inshore fishing in the Merizo/Cocos Lagoon region are gill and surround netting, and spearing. However, computed average annual estimates of participation, effort and catch (Table 7) show spearing to be by far the most popular inshore method in terms of the number of persons, number of trips and the amount of person-hours expended. The difficulty of observing spearing activity during inshore creel censuses and the advantage of censusing spearing participation from the air are clearly indicated by these results.

Table 5. Time of occurrence and numbers of flights for Aerial Fisheries Surveys reported since FY'63. W = Weekday Flights; H = Holiday Flights (including weekend)

FISCAL YEAR	MONTHS	No. WD	No. WE	TOTAL
1963	7/62 - 6/63	9	9	18
1964	7/63 - 6/64	11	11	22
1965	7/64 - 6/65	12	11	23
1966	7/65 - 6/66	7	8	15
1967	7/66 - 6/67	6	7	13
1975	1/75 - 6/75	6	6	12
1976	8/75 - 10/76	11	9	20
1978	7/77 - 6/78	12	12	24
1979	7/78 - 6/79	11	10	21
TOTAL		85	83	168

Table 6. Numbers of People, Boats and Marine life seen during Aerial Fisheries Surveys within the Merizo/Cocos Lagoon area at various times since July 1962. See text for explanation.
 * = Data not recorded.

	FY'63	FY'64	FY'65	FY'66	FY'67	FY'75	FY'76	FY'78	FY'79	TOTAL
INSHORE FISHING:										
Hook & Lining	23	19	22	7	15	2	6	15	5	114
Cast Netting	25	18	16	7	12	0	5	14	1	98
Gill & Surround Netting	3	20	55	30	13	5	40	44	11	221
Spearing	24	45	47	33	10	16	13	11	6	205
Octopus Hunting	0	0	0	0	0	0	0	0	0	0
Clamming	*	*	*	*	*	*	*	8	4	12
Weir Tending	*	*	*	*	*	*	*	27	17	44
TOTAL	75	102	140	77	50	23	64	119	44	694
OFFSHORE FISHING:										
Trolling Boats	0	8	18	9	5	5	12	16	17	90
Bottom Fishing Boats	0	4	3	2	1	1	6	4	3	24
Dive Boats	0	0	0	0	0	1	0	3	10	14
TOTAL	0	12	21	11	6	7	18	23	30	128
NON-FISHING:										
Unident. Persons	15	29	19	6	4	1	4	14	31	123
Surfers	*	*	*	*	*	*	*	0	7	7
Picnickers	*	*	*	*	*	*	*	1431	949	2380
TOTAL	15	29	19	6	4	1	4	1445	1987	2510
Other Boats	0	0	0	0	0	2	2	34	55	93
MARINE LIFE:										
Sharks	2	2	4	0	0	5	10	2	3	28
Turtles	1	0	5	0	0	9	9	3	1	28
Porpoise	0	0	0	0	0	0	0	0	0	0

Table 7. Estimated annual participation, effort and catch for inshore fishing within the Merizo/Cocos Lagoon region based on aerial fisheries survey data.

Fishing Method	Est. #Pers. Per Year	Est. #Trips Per Year	Est. #Pers.-Hrs. Per Year	Est. #Gear-Hrs. Per Year	Est. #kg Per Year
Hook & Line	715	376	2598	2560	512
Cast Net	806	474	2086	2086	834
Gill Net	674	270	2401	1025	718
Surround Net	508	86	2247	353	1836
Spear	1507	486	4909	1361	408
Other	420	191	1280	478	191
TOTAL	4630	1883	15521	7863	4499

Table 8. Comparison of participation rates between inshore creel census and aerial survey data, and mean estimated annual participation, effort and catch for inshore fishing within the Merizo/Cocos Lagoon region. * = based on island-wide data from FY 79-81; ** = based on (W) level of 0.4 persons/census.

Fishing Method	#Pers./Cens. (Creel)		#Pers./Flt. (Aerial)	Est. #Pers. Per Year	Est. #Trips Per Year	Est. #Pers-Hr Per Year	Est. #Kg Per Year
Hook & Line	0.2	0.8	0.7	575	310	2,003	393
Cast Net	0.4	0.7	0.6	740	436	1,883	749
Gill Net	1.0	0.9	0.7	837	335	2,820	833
Surround Net	0.8*	1.7	0.6	596**	100*	2,717*	2,142**
Spear	0.3	0.7	1.2	1,014	328	3,348	277
Other	0.2	0.05	0.3	306	137	911	138
TOTAL				4,068	1,646	13,682	4,532

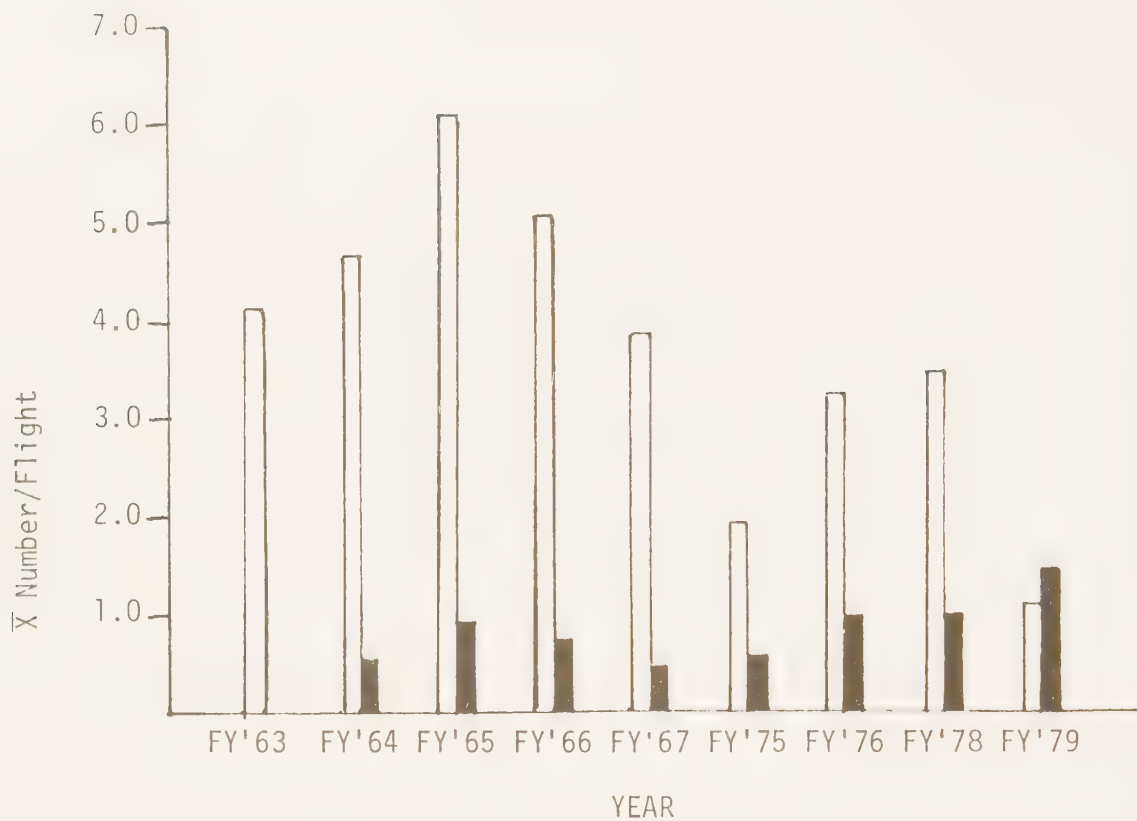


Figure 2. Mean number of inshore fishermen & fishing boats (shaded) seen in the Merizo/Cocos Lagoon area during Aerial Fisheries Surveys conducted at various times since July 1962.

Table 8 is a comparison of the mean numbers of persons seen per census during the inshore creel censuses with the mean numbers of persons seen per flight during the aerial surveys. Annual estimates of daytime participation, effort and catch for 292 fishable days per year (80%) were calculated based on each of these data sets (creel and aerial) and then averaged to provide the best estimates presented in Table 8. In terms of recreational use, the results show spearing and gill netting to be the most popular methods employed. When the annual harvests estimated from inshore creel census and aerial survey data are averaged a value of 4532 Kg/yr results. If the estimated annual nighttime catch of 3504 Kg/yr is added to this figure, our overall best estimate of average annual inshore harvest attributable to the primary inshore fishing methods, excluding the average annual fish weir catch, is approximately 8036 Kg/yr.

The most popular offshore fishing method appears to be trolling. Figure 2 shows the yearly mean numbers of inshore fishermen and offshore fishing boats observed in the region per flight. This graph seems to indicate an overall reduction in the "instantaneous" levels of inshore fishing activities between the 1960's and the 1970's, while offshore fishing activities may be increasing slowly. These numbers are too small, however, for us to use as a basis for any definite statement on trends.

Summary

To date, DAWR has not carried out an in-depth investigation of the fishing activities that occur specifically within the Merizo/Cocos Lagoon region. However, enough data has been gathered during various island-wide surveys to allow us to make some minimum estimates of participation, effort and catch for the region. To summarize, calculations based on our data have resulted in an estimated average annual inshore harvest attributable to the following sources:

4925 Kg	- Fish weirs
4532 Kg	- Daytime inshore fishing
3504 Kg	- Nighttime spearfishing
12961 Kg	- Estimated total inshore harvest

A combined estimated average annual inshore-offshore harvest for the region may be broken down as follows:

12961 Kg	- Inshore harvest
17286 Kg	- Offshore harvest
30247 Kg	- Estimated total inshore - offshore harvest

It should be remembered that these figures do not account for fish harvested at night through inshore methods other than spearing, seasonal catches of manahac, offshore day and nighttime bottomfishing or catches resulting from the use of illegal fishing methods.

Report prepared by: Michael E. Molina

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-19

SUB-PROJECT NO.: F

STUDY NO.: F-1

JOB NO.: 3

JOB TITLE: Data Processing for Creel Census

PERIOD COVERED: October 1, 1981 to September 30, 1982

SUMMARY

Fishing activities on Guam have been surveyed by the Division of Aquatic and Wildlife Resources (DAWR) for many years in order to identify trends in fishing effort and catch among various types of fishing methods employed, and to assess the state of the exploited fish stocks. This historical creel census information has been examined for procedural details and results. An Apple II microcomputer was installed at DAWR and approximately 5500 computer records have been generated. Preliminary participation and catch reports have been prepared. Creel Census procedures are being redesigned to improve efficiency and statistical reliability.

BACKGROUND

Surveys of fishing activities on Guam were initiated by DAWR in mid-1960 and although procedural changes have occurred, sampling at some level has been maintained continuously. To date, however, little attempt has been made to analyze and interpret the accumulated results of these survey efforts due to the voluminous nature of the data, difficulties caused by variations in sampling procedures and discontinuity created by personnel changes.

Early inshore surveys were conducted along three shoreline routes at a frequency of about two days per month. An unknown portion of the fishermen encountered were interviewed for "effort" information and their catches were examined. Common fish names and British units of measurements were used to record biological data, often by nonbiologically-trained personnel (Conservation Law Enforcement Officers) prior to 1977. As a result, species misidentifications and data inaccuracies are suspected, while design and procedural details needed for analysis are lacking. Therefore, for the current analyses, inshore creel census information collected prior to 1977 will be excluded. Also, 1977 marks the year in which serious attempts to monitor Guam's offshore fishing activities were begun.

In addition, aerial surveys were performed intermittently from mid-1960 to mid-1979, to obtain roughly instantaneous assessments of island-wide inshore fishing activities. Occasional observations of offshore activities were also recorded. A summary of the frequencies and procedures of these surveys

is included in a sub-section of the FY 82 Inshore Creel Census analysis, entitled "Fisheries Information Related to the Merizo/Cocos Lagoon Region".

As Guam's fisheries have come under considerable and increasing pressure from recreation, subsistence and commercial interests, as well as destructive illegal fishing practices, the need to assess and manage these resources has also become high. To help satisfy this need, Job 3, Data Processing for Creel Censuses, was reactivated in FY 82. In addition, DAWR is funded by the National Marine Fisheries Service (NMFS) to participate in the Western Pacific Fisheries Information Network (WPACFIN) program. As the goals of these programs overlap considerably, this report presents the progress made during FY 82 in analyzing creel census information regardless of program.

OBJECTIVES

General objectives and goals of these programs include, but are not limited to the following:

1. Computerize historical and current creel census data.
2. Transfer finalized computer files to the NMFS, HB 11/70 computer in Honolulu, for region-wide application and exchange.
3. Increase the efficiency and statistical reliability of data collection and handling.
4. Obtain reliable estimates of total island-wide harvest from the inshore and offshore fisheries.
5. Obtain estimates of harvest and productivity for specific reefs and habitat categories.
6. Assess individual fishing methods for effectiveness and selectivity.
7. Obtain population and life history information for selected harvested fish species.

RESULTS

During this fiscal year efforts were directed primarily at summarizing past inshore creel census surveys (1977-1981) to evaluate their results and determine future survey needs. Therefore, the following is primarily a description of these surveys, on which future analyses may be based. Progress made in the computerization of the creel census data is also reported.

Inshore Creel Census

The primary inshore fishing methods employed on Guam include hook and line fishing, cast netting, gill netting, surround netting, spearfishing and octopus hunting with gaffs and hooks. Common secondary methods include collecting bivalves, gastropods, crustaceans, echinoderms and algae with trawls, rakes, bars or by hand.

Three shoreline regions have consistently been surveyed for these inshore fishing activities (Figure 1). Region 1 begins at Fafai (Gun) Beach near the base of Two Lovers Point and extends southerly along the leeward side of Guam to Adelup Point. Heavily fished areas within this region include Tumon Bay, Agana Bay and the Agana Boat Basin. Based on analysis of combined data from calendar years 1980 and 1981, this region accounts for approximately 44% of the fishermen encountered during inshore creel censuses and about 60% of the total catch examined (Table 1). The greatest number of censused persons (between 40 and 60%) using octopus hooks, surround nets, fish spears, and hook and line gear during these two calendar years were encountered in this region. Most of the hook and line fishermen were seen at the Agana Boat Basin where atulai (Selar crumenophthalmus) are seasonally abundant.

Region 2 begins at the southern side of Adelup Point and includes the popular areas of Asan Bay, Apra Harbor and Agat Bay and ends at Nimitz Beach. During the 1980-81 period, 27% of all fishermen and 17% of the total catch examined, were from this region (Table 1). This area accounted for approximately 25% of all fish spear, gill net, cast net and hook and line fishermen encountered during these years.

Region 3 begins at Toguan Bay between Umatac and Merizo and extends around the southern and southeastern sides of Guam up to and including Pago Bay. Although Cocos Lagoon is included within this area, it should be noted that due to sampling difficulties, very little information has been collected in the lagoon proper.

During the years 1980-81, Region 3 accounted for 29% of the fishermen encountered and 24% of the total catch. Of the areas censused, the greatest number of gill netters (51%) and cast netters (43%) were encountered within Region 3 (Table 1).

These three regions are adjacent to the most heavily populated areas of the island, and include the most accessible fishing reefs and approximately 60% of the total island coastline. Lack of access roads, military restrictions and/or unsuitable coastlines limit fishing in many of the remaining areas. Based upon 168 aerial surveys conducted in FY 63-67, 75-76, and 78-79, approximately 87% of the island-wide fishing occurs within the three censused regions (Table 2).

Table 3 presents the actual creel census dates for the years 1977 through 1981. During the 1977 report period censuses were conducted at a frequency of two per month while six censuses per month were made during the remaining years. Creel census days were selected randomly for each month, with a near equal distribution between holidays (including weekends) and weekdays. No two regions were sampled on the same day, with some exceptions in FY 81. Surveys were usually conducted between 0800 and 1700 hours.



Figure 1. The island of Guam. The Inshore Fishing Census Regions are as follows: Region #1 - Gun Beach to Adelup Pt.
 Region #2 - Adelup Pt. to Nimitz Beach
 Region #3 - Toguan Bay to Pago Bay

Table 1. Total number and percentage, of fishermen interviewed and kilograms of catch examined, by method and region, for combined calendar years 1980 and 1981.

Region	#Persons	Total %	Total #Kg	Hook & Line %	Hook & Line #Persons	Cast Net %	Cast Net #Persons	Gill Net %	Gill Net #Persons	Surround Net %	Surround Net #Persons	Spear %	Spear #Persons	Octopus Hooks %	Octopus Hooks #Persons	
1	1326	44.0	1042.7	60.0	676	56.2	162	32.1	124	23.8	212	57.1	84	40.8	68	48.6
2	786	27.0	285.4	16.5	342	28.4	127	25.2	133	25.6	70	18.9	59	28.6	55	48.6
3	832	29.0	409.0	23.5	185	15.4	215	42.7	263	50.6	89	24.0	63	30.6	17	12.1
TOTAL	2944	100	1737.1	100	1203	100	504	100	520	100	371	100	206	100	140	100

Table 2. Percentage, by method, of fishermen observed within Inshore Creel Census Regions (C) and Non-Censused Regions (NC), during 168 Aerial Fisheries Surveys.

Fiscal Year	Method and Region													
	Hook and Line		Cast Net		Gill and Surround Nets		Spear		Octopus Hook		Clamming		Yearly Totals	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
'63	96.3	3.7	85.6	14.4	91.4	8.6	75.7	24.3	-	-	-	-	87.2	12.8
'64	91.8	8.1	81.7	18.3	75.8	24.2	86.4	13.6	-	-	-	-	83.3	16.7
'65	89.8	10.2	82.0	18.0	86.8	13.2	78.5	21.5	-	-	-	-	85.0	15.0
'66	92.0	8.0	80.8	19.2	93.3	6.7	85.6	14.4	-	-	-	-	90.2	9.8
'67	94.3	5.7	85.0	15.0	94.7	5.3	87.1	12.9	-	-	-	-	91.1	8.9
'75	95.8	4.2	68.3	31.7	94.2	5.8	87.0	13.0	-	-	-	-	90.8	9.2
'76	88.7	11.3	71.3	28.7	90.7	9.3	68.7	31.3	-	-	-	-	83.7	16.3
'78	96.5	3.5	71.7	28.3	96.6	3.4	71.4	28.6	97.0	3.0	100.0	0.0	88.6	11.4
'79	92.3	7.9	78.2	21.8	90.5	9.5	78.4	21.6	100.0	0.0	100.0	0.0	87.1	12.9
Survey Totals	93.1	6.9	79.7	20.3	90.1	9.9	80.0	20.0	98.4	1.6	100.0	0.0	87.0	13.0

Table 3. Guam Aquatic & Wildlife Resources Inshore Creel Census Days for FY 1977
H = Holiday (including weekends), W = Weekday; * = Turnover

Month	Gun Beach- Adelup Pt.		Adelup Pt.- Nimitz Beach		Pago Bay- Toguan Bay		# Census-Days /Mo.	
	H	W	H	W	H	W	H	W
Jan 77	15	6	8	19	23	13	3	3
Feb 77	12	3	19	10	5	16	3	3
Mar 77	19	9	5	17	12	1	3	3
Apr 77	16	6	9	20	23	13	3	3
May 77	12	21	18	7	14	25	3	3
Jun 77	17	4	18	8	11	22	3	3
TOTAL # DAYS	6	6	6	6	6	6	18	18

Total # Census-Days = 36
Total # Route-Days = 36

Table 3 Continued: Inshore Creel Census Days for FY 1978
H = Holiday (including weekends), W = Weekday

Month	Gun Beach- Adelup Pt.		Adelup Pt.- Nimitz Beach		Pago Bay- Toguan Bay		# Census-Days /Mo.	
	H	W	H	W	H	W	H	W
Ju1 77	9	20	16	15	23	6	3	3
Aug 77	6	17	20	10	13	3	3	3
Sep 77	17	8/30	24	7	10	14	3	3
Oct 77	15	4	8	19	22	12	3	3
Nov 77	5	23	12	2	19	10	3	3
Dec 77	3	14	10	28	17	7	3	3
Jan 78	14	18	28	11	21	4	3	3
Feb 78	11		26	25	19	1	3	2
Mar 78	26	14	5	31	25	10	3	3
Apr 78	16		14	22	8	26	3	2
May 78	6	22			27	5	2	2
Jun 78	24	9	4	23	18	30	3	3
TOTAL #DAYS	12	10	11	11	12	12	35	33

Total # Census-Days = 68
Total # Route-Days = 68

Table 3 Continued: Inshore Creel Census Days for FY 1979
H = Holiday (including weekends), W = Weekday

Month	Gun Beach- Adelup Pt.		Adelup Pt. - Nimitz Beach		Pago Bay - Toguan Bay		# Census - Days /Mo.	
	H	W	H	W	H	W	H	W
Ju1 78	23	11	16	18	29	20	3	3
Aug 78	27	10	6	21	19	14	3	3
Sep 78	9	22	24	12	8	15	3	3
Oct 78	29	6	14	14	8	20	3	2
Nov 78	11	27	19	14	26		3	2
Dec 78	23	4	16	27	17	26	3	3
Jan 79	13	19	21	3	2/4	11	3	3
Feb 79	19	9	3	21	18	12	3	3
Mar 79	10	23	11	28	31	12	3	3
Apr 79	28	5	30	27	29	11	3	3
May 79	20	1	5	30	20	15	3	3
Jun 79	16	11	3	19	24	5	3	3
Jul-Jun Sub-Totals:								
# Days	12	12	12	11	12	11	36	34
# Census-Days =	70							
Ju1 79	28	11	1	26	20		3	2
Aug 79	18	10	12	28	25	7	3	3
Sep 79	16	13	2	19	22	10	3	3
Oct-Sep Sub-Totals:								
# Days	12	12	12	11	12	10	26	33
# Census Days =	69							
TOTAL # DAYS	15	15	15	14	15	13	45	42

Table 3 Continued: Inshore Creel Census Days for FY 1980
H = Holiday (including weekends), W = Weekday

Month	Gun Beach- Adelup Pt.		Adelup Pt.- Nimitz Beach		Pago Bay- Toguan Bay		# Censused-Days /Mo.	
	H	W	H	W	H	W	H	W
Oct 79	20	5	6	17	28	10	3	3
Nov 79	11 25	9 29	12		15	22	4	3
Dec 79		12	8 23		29	6	3	2
Jan 80	27	9	5	18	26	17	3	3
Feb 80	16	7	2	22	24		3	2
Mar 80	30	4	8	17	22	18	3	3
Apr 80	19	15	12	22	26	30	3	3
May 80	11	28	25	8	31	30	3	3
Jun 80	7	26	28	13	28		3	2
Jul 80		23 31	19	10	12		2	3
Aug 80		8	3	19	31	29	2	4
Sep 80	27			23	21	12	2	2
TOTAL #DAYS	10	14	12	10	12	9	34	33

Total # Census-Days = 67

Table 3 Continued: Inshore Creel Census Days for FY 1981
H = Holiday (including weekends), W = Weekday

Month	Gun Beach- Adelup Pt.		Adelup Pt.- Nimitz Beach		Pago Bay- Toguan Bay		# Census-Days /Mo.	
	H	W	H	W	H	W	H	W
Oct 80								
Nov 80	8 30	19	29		19		3	1
Dec 80	21	3		19 22	21	8	1	4
Jan 81					29			1
Feb 81		24			11		1	2
Mar 81	15	23	1	20	13		2	3
Apr 81	12	8	26	14	25	7	3	3
May 81	16	26	23	21	30	29	3	3
Jun 81	7	24	6		29	12	3	2
Jul 81	18	7	25		18	16	2	2
Aug 81	16		23 30		22	7 11	4	2
Sep 81	13	29	27	30	5	12	3	3
TOTAL #DAYS	10	9	9	6	8	12	25	26

Total #Census-Days = 51

A summary of the results of inshore fishermen interviews, for this period is presented in Table 4. It should be noted that the report periods among fiscal years did not remain consistent and, therefore, total harvest estimates are not directly comparable. However, the relative popularity of the different fishing methods and their catch rates may be obtained from this table. Expansion of actual data to obtain participation, effort and harvest estimates were generally calculated in the following manner. For each month and fishing method, mean participation (number of persons) and effort (number of person-hours and gear-hours) were calculated separately for censused holidays and weekdays. These values were multiplied by the total number of holidays or weekdays within that month and summed to give total monthly estimates. These monthly estimates for each fishing method were then summed to yield annual (or report period) total estimates. Monthly and annual harvest estimates were derived by multiplying actual CPUE values (kg/person-hour or kg/gear-hour) by the estimated numbers of person-hours or gear-hours per month and year, respectively. The annual estimates were subjectively adjusted to account for variable weather conditions in some years but not in others (minus 0 to 20%). Fishing in uncensused areas, night fishing, fishing performed at times of the day other than during the census period or by the use of illegal methods such as poisoning or explosives were not evaluated. However, these factors were considered and incorporated into the final "best estimate" by subjectively doubling the calculated annual estimates. Also, seasonal catches of manahac (juvenile Siganus spinus and S. argenteus) and atulai (Selar crumenophthalmus) were included in the total annual harvest estimates.

Offshore Creel Census

The offshore fishery of Guam consists primarily of part-time fishermen who utilize small craft of under 30 feet in length. Typically, the catch is either sold to offset the cost of operation, consumed personally or given to family and friends. In addition, a small number of commercial operators fish the waters and nearby banks of Guam. The two main launching sites are the Agana Boat Basin (ABB), centrally located on the leeward side of the island, and the Merizo Pier (MP) located within Cocos Lagoon at the southern end of Guam. Smaller boat ramps are located at several rivers and bays around the island and in Apra Harbor.

The first serious attempts to survey offshore fishing on Guam were begun in 1977, and have been maintained at some level since then. During 1977 surveys were conducted at the Agana Boat Basin on one weekday and one holiday (including weekends) per month. The ABB was sampled four times per month (2 weekdays and 2 holidays) from 1978 to the present. The Merizo Pier was sampled twice per month beginning in 1978, however this was discontinued in 1982 due to personnel and time constraints. Sample days were selected randomly. The ABB was censused between 0600 and 2100 hours in FY 77-78, and on weekends in FY 79. On weekdays in FY 79, and all census days in FY 80-81, the ABB and MP were censused between 1400 and 2100 hours.

Trolling, bottomfishing and spearfishing are the most popular offshore fishing methods. Estimates of participation, effort and catch were calculated in the same general manner as in the inshore creel census analysis. Since 1977, the annual estimates were subjectively adjusted to account for the effect of variable weather conditions (usually minus 20%).

Table 4. Summary of Inshore Creel Census Results, FY 77-81. Variability in fiscal year length and census effort among fiscal years make totals not directly comparable.

Fiscal Year	Fishing Method	No. Persons interviewed	Gear-Hours	Actual Catch(Kg)	Catch/Fishing Hr.	Estimate Catch/FY
'77 (6 mo.)	Hook & Line	147	91.6	17.1	0.19	308.1
	Cast Net	142	145.3	450.5	3.1	352.7
	Gill/Surround	354	141.4	343.9	2.43	4814.0
	Spear	28	13.3	15.3	1.2	237.3
	TOTAL	671	391.6	826.8	2.1	5712.1
'78 (12 mo.)	Hook & Line	439	707.9	146.4	0.2	1,387
	Cast Net	204	232.3	164.6	0.71	1,421
	Gill Net	425	241.5	297.3	1.23	3,063
	Surround Net	182	45.5	308.2	6.77	3,574
	Spear	172	169.3	80.6	0.48	737
	TOTAL	1422	1396.5	997.1	0.71	10182
'79 (15 mo.)	Hook & Line	821	1665.7	178.5	0.11	1,619
	Cast Net	233	310.2	116.8	0.38	1,160
	Gill Net	391	466.6	359.3	0.77	3,821
	Surround Net	317	58.0	361.7	6.24	3,981
	Spear	176	246.1	233.3	0.95	1,884
	TOTAL	1938	2746.6	1249.6	0.45	12,465
'80 (12 mo.)	Hook & Line	447	1173.9	146.6	0.12	1,702
	Cast Net	163	249.1	123.6	0.5	1,619
	Gill Net	193	570.5	201.0	0.35	1,821
	Surround Net	134	54.0	549.4	10.2	11,400
	Spear	55	80.2	49.2	0.6	688
	TOTAL	992	2127.7	1069.8	0.50	17,210
'81 (12 mo.)	Hook & Line	554	1436.4	134.7	0.09	1,614
	Cast Net	233	252.7	87.8	0.35	890
	Gill Net	196	108.9	58.8	0.54	1111
	Surround Net	148	63.0	224.6	3.6	4194
	Spear	69	91.5	30.8	0.34	322
	TOTAL	1200	1952.5	536.7	0.27	8,131

This year, however, the estimates have been adjusted to reflect the number of days no known fishing occurred due to inclement weather, the limited amount of fishing that occurred on marginally rough days and fishing done at times other than during the census periods. Offshore catches landed at locations other than the ABB and MP have been estimated on an island-wide basis of four boats per day. Table 5 presents the results of the offshore creel censuses from FY 77-81. The totals are not directly comparable due to sampling differences and variation in report period length, however they are presented here for future reference.

Computerization

In November, 1981 meetings of the Data Goals Committee and the Technical Subcommittee of the WPACFIN program were held in Honolulu, Hawaii. These meetings were organizational in nature, and attended by committee members from the DAWR, the Commonwealth of the Northern Marianas, American Samoa and NMFS. In February, 1982, Mr. D. Hamm (NMFS) completed the installation of DAWR's microcomputer and conducted training sessions.

Computerization of the creel census data has involved several stages. All interview forms to be used (1977-1982) are first evaluated for accuracy by biologically-trained personnel. Items of particular concern include dates, locations, species identifications and numerical and biological data such as fish lengths and weights. Lengths and weights for individual species, as well as total catch weights are categorized in the following manner. If field determination of lengths or weights were made for individual fish or total catch, the data are categorized as "actual". When lengths were taken in the field and weights estimated by using a graph or table of length/weight relationships, such a weight is categorized as "calculated". Finally, when field personnel "estimated" lengths or weights without the use of measuring tapes or scales, the data are categorized as such. These three categories of numerical data will permit retention of data integrity in future analyses.

In addition, numerical codes were devised for pertinent information collected on the interview forms. These include codes for fishing locations, fishing methods, reef zones, and bait, as well as tidal, surf and weather conditions.

A data management software program (DB Master) is being used for the actual entry of data. All inshore interview forms for the calendar years 1980 and 1981 have been entered and edited. These two years alone have generated approximately 5500 computer records. Preliminary participation and catch reports, segregating data by method, month, location and tidal period have been generated.

RECOMMENDATIONS

Although flawed in certain respects, past creel census efforts have provided reliable information on the following:

1. Catch per unit effort for gill netting, surround netting, hook and lining, cast netting, octopus hunting, trolling, bottomfishing and spearfishing.

Table 5. Summary of Offshore Creel Census Results, FY 77-81. Variability in fiscal year length and census effort among fiscal years make totals not directly comparable.

Fiscal Year (Mo.)	Fishing Method	No. Boats	No. Persons Interviewed	*Person-hrs.	Actual Catch (Kg)	Catch Per Hr.	Estimated Catch/FY
'77 (Jan '77-Jun '77)	Trolling	103	274	*628.7	3478.1	*5.5	53878.4
	Bottomfishing	12	32	* 89.8	231.5	*2.6	2520.1
	Spearfishing	12	4	* 26.5	162.1	*6.1	2555.8
	TOTAL	127	310	*745.0	3871.7	*5.2	58954.3
'78 (July '77 - June '78)	Trolling	2785	8069	48,645	Not Available	1.74	84,879
	Bottomfishing	468	1287	10,835		1.22	13,189
	Spearfishing	283	838	4,307		1.32	5,668
	TOTAL	6,321	10,194	63,787		-	103,736
'79 (July '78 - Sept '79)	Trolling	508	1508	9282.9	9376.2	1.01	67,141.0
	Bottomfishing	53	190	1017.7	769.9	0.76	5,454.0
	Spearfishing	20	86	350.4	228.3	0.65	1,338.0
	TOTAL	581	1784	10951.0	10374.4	.95	73,933.3
'80 (Oct '79 - Sept '80)	Trolling	1,541	4323	21090	Not Available	2.2	46,531
	Bottomfishing	305	738	*1447		*0.89	2,867
	Spearfishing	113	363	939		0.82	775
	TOTAL	1959	5424	-		-	50,173
'81 (Oct '80 - Sept '81)	Trolling	257	716	4116.5	7105.5	1.82	67768.0
	Bottomfishing	58	145	714.5	1054.1	1.48	5359.4
	Spearfishing	13	37	127.7	179.3	1.4	956.2
	TOTAL	328	898	4958.7	8338.9	1.68	74,083.6

* These values = boat-hours, and catch per boat-hour.

2. Estimates of average trip length per fishing method.
3. Estimates of number of persons per fishing party per method.
4. Catch composition for the various fishing methods.
5. Biological information such as fish lengths and weights, and seasonality of important fish species.

However, past designs have been inadequate in obtaining reliable total estimates of fishermen participation and, therefore, total catch estimates. From a management perspective, it would be valuable to obtain these estimates for specific reef areas and habitat categories as well for the whole island. It is recommended that this program be continued to permit the evaluation of past information, and the redesigning of future surveys to meet these needs. In December, 1982, Mr. E. Brazier, a NMFS-funded statistical consultant, spent a week on Guam studying the current creel census program. His results are pending but it is anticipated that new designs will be implemented.

Report prepared by: Alan J. Hosmer and Michael E. Molina



JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-19
SUB-PROJECT NO.: F
STUDY NO.: F-1
JOB NO.: 5

JOB TITLE: Reef Fish Population Investigations through the use of
Permanent Transects

PERIOD COVERED: October 1, 1981 to September 30, 1982

SUMMARY

Coral-reef fishes were monitored monthly at four upper reef-slope depths (5, 9, 18 and 30 m) at two locations on Guam between September 1979 and November 1980. Overall fish density increased markedly at all depths during the spring and summer months, corresponding to the onset of the rainy season and the diminishing of the tradewinds. Maximum abundances were recorded between May and July. A less pronounced increase in fish abundance occurred in the fall. Most of the observed seasonal variation in abundance resulted from juvenile recruitment and the movements of subadults and adults of a relatively small group of abundant species at each depth. Planktivores, piscivores and benthic-invertebrate feeders, primarily in deeper water, were largely responsible for the spring/summer peak, while the fall increase was significantly influenced by herbivores at shallower depths. Fluctuations of fish abundance may be related to variations in the availability of food resources. Climatological and oceanographical phenomena may have favorably influenced food resource availability as well as reproductive success during certain months. Estimates of site- and depth-related annual variation in abundance and species composition of 35 ubiquitous fish species indicated relative constancy over extensive areas of reef. Fish species richness was found to be greatest at 18 m. An explanation for this trend in species richness based on the "intermediate disturbance hypothesis" is offered.

BACKGROUND

During 1978 and 1979, the Division of Aquatic and Wildlife Resources (DAWR) used a steel barge artificial reef to increase the available fish habitat near the 18-m depth contour on the upper reef slope. During that project, fish counts made over a period of 20 months on the barge and along line transects permanently placed over surrounding areas of natural reef were used to monitor changes in the fish community. A result of the study was the documentation of a marked seasonal fluctuation in total fish abundance over the natural reef areas (Kock 1982). Seasonal increases among certain species were attributed partly to the immigration of adults

and older juveniles, and partly to juvenile recruitment. Although no spawning peaks were observed, maximum settlement of juveniles occurred between March and June, and the highest overall fish abundance was recorded in May. Lowest overall abundance occurred during the winter months and reached similar levels in both years. Annual variability in species composition of the fish community was not examined.

Since it would be quite useful for fisheries managers and other ecologists to know how seasonal and annual fluctuations in fish abundance are manifested at different depths on the upper reef slope, the present investigation was undertaken. Work accomplished in this study has been reported annually since FY 79. Since that time the project has undergone revisions in its scope although its major objective has remained the same. This account is the final report for Job 5 and, therefore, supersedes all previous progress reports. It also represents an edited version of an M.S. thesis submitted to the Marine Laboratory, University of Guam.

OBJECTIVE

The objective of this study is to document the patterns of seasonal and annual variability within the conspicuous upper reef-slope fish community as they are manifested along a depth-related environmental gradient over a 15-month time period.

PROCEDURES

Study Sites

Fishes were monitored on the upper reef slope at Asan Pt. and Ipao Pt. on the leeward (western) side of Guam (Figure 1). Randall and Holloman (1974) stated that this zone in the Asan area is very similar to that found near Ipao Pt. At both sites the coral community showed evidence of past disturbance from Acanthaster predation.

Fishing effort observed in the vicinity of the transects during the study was minimal. In addition, monthly DAWR interviews of offshore anglers and divers returning to the Agana Boat Basin after fishing near either study site were relatively few both before and during the study period. Thus, the fishing pressures that occurred at both sites during the study are estimated to be relatively light and comparable in degree.

Transect Stations

During the spring of 1979, duplicate 50-m transects were placed along approximate depth contours of 5, 9, 18 and 30 m at each study site. A transect consisted of six unconnected rebar stakes embedded into reef rock at 10-m intervals. All stakes were flagged with a piece of yellow plastic marking tape to make them easier to locate on subsequent field days.

Data for the study were recorded on a submersible microcassette tape deck. Both the plexiglass housing for the tape deck and the special scuba-regulator mouthpiece containing the remote microphone were manufactured under the name "Wet-Tape" by Sound-Wave Systems, Inc.

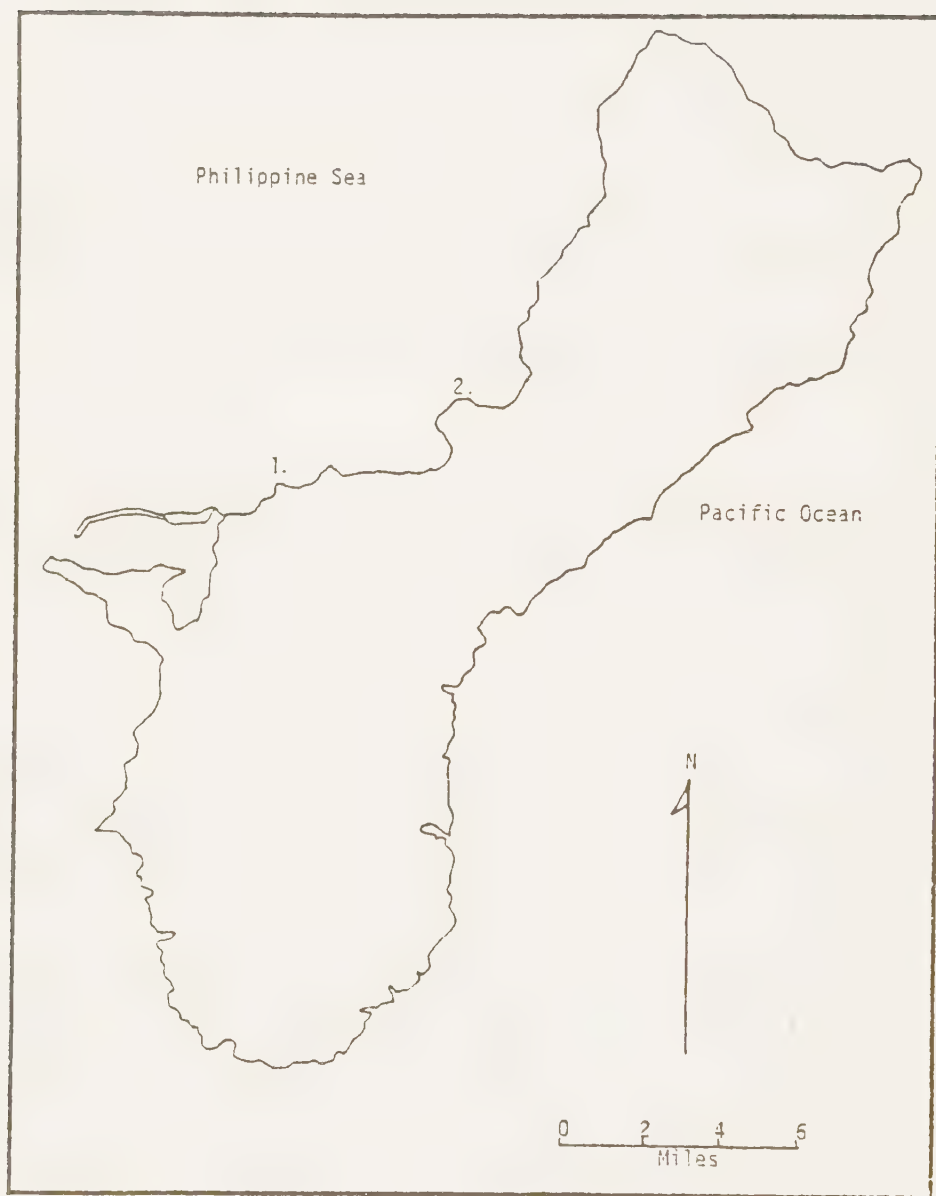


Figure 1. Map of Guam showing the locations of the Asan Pt. and Ipao Pt. study sites. 1. = Asan Pt.; 2. = Ipao Pt.

Formal monthly fish counts were begun in September 1979. Data collection was limited to the time between 1000 and 1400 hrs. Counts of individuals were made for all fish species observed as much as two meters above the substrate within a two-meter wide path between stakes. Dives were limited to a maximum of two depths per day, normally paired as 30 and 5 m, and 18 and 9 m. On a single field day, both 50-m transects at each of the two depths were censused twice (down and back) yielding monthly counts of fish over 400 m² of reef at each depth. Four to six field days per month were required to census the transects. Data collection was terminated with the November 1980 censuses.

Data Analyses

The Wet-Tape recording system failed temporarily in January 1980, resulting in the deletion of that month from the analysis. The system failed permanently after August 1980 so the remaining counts were compiled by hand. Because of the relatively short no-decompression time limit (25 minutes) for dives to 30 meters, and since it took longer to write down observations than it did to speak them, there was sufficient safe bottom time to record data on only one pass along these transects during the last three months of the study. These counts were, therefore, adjusted to reflect the number of individuals per 400 m² before being analyzed. To make the overall analysis more manageable, a conservatively selected subset of ubiquitous fish species was formed. Species composing this group were selected if they were counted on at least seven of the eight transect stations. The 35 species that qualified were used to compare seasonal climatological patterns with observed seasonal fluctuations in fish abundance.

Representative seasonal peak abundances for each of the most ubiquitous species were identified by their maximum mean monthly counts. Depths of greatest representation were chosen for each of these species based on the highest mean number per depth when the counts for all months were combined. In addition, each of the 35 most ubiquitous species was assigned to a general trophic category based on Hiatt and Strasburg (1960), Jones (1968), Randall and Klauswitz (1973), Hobson (1974), Allen (1975), and Ogden and Lobel (1978). Thus, trends in peak abundances across depths and over months could be related to general food habits.

Observed changes in overall fish abundance were compared with seasonal patterns of average monthly rainfall (Fig. 2) based on 24 years of Guam precipitation data from the National Oceanic and Atmospheric Administration (NOAA) (1979, 1980) and with seasonal shifts in average monthly wind patterns (Fig. 3) based on 21 years of unpublished data provided by the U. S. Naval Oceanography Command Detachment (NOCD), U. S. Naval Air Station, Guam. To examine further the influences carnivores and herbivores may have had on the overall counts during different periods of the year, these trophic groups were expanded to consist of 28 species each. These species included the carnivores and herbivores within the most ubiquitous group, as well as additional species which occurred frequently and were of notable abundance.

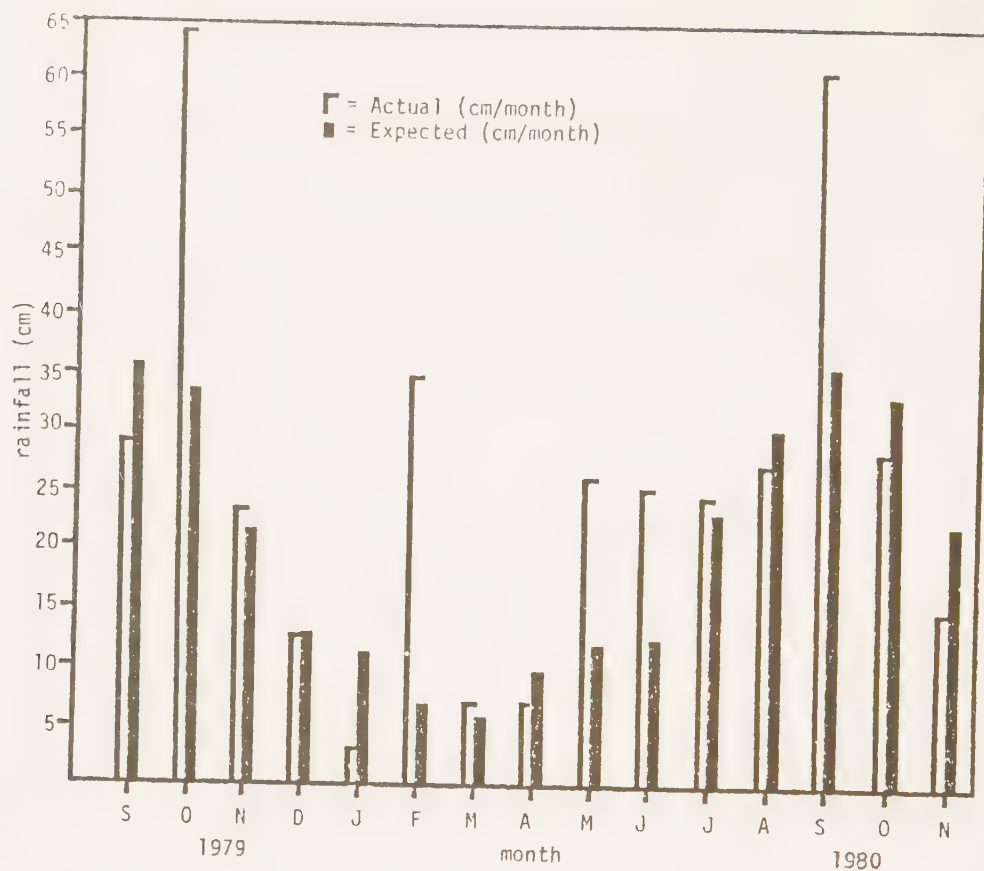


Figure 2. Monthly rainfall on the island of Guam.

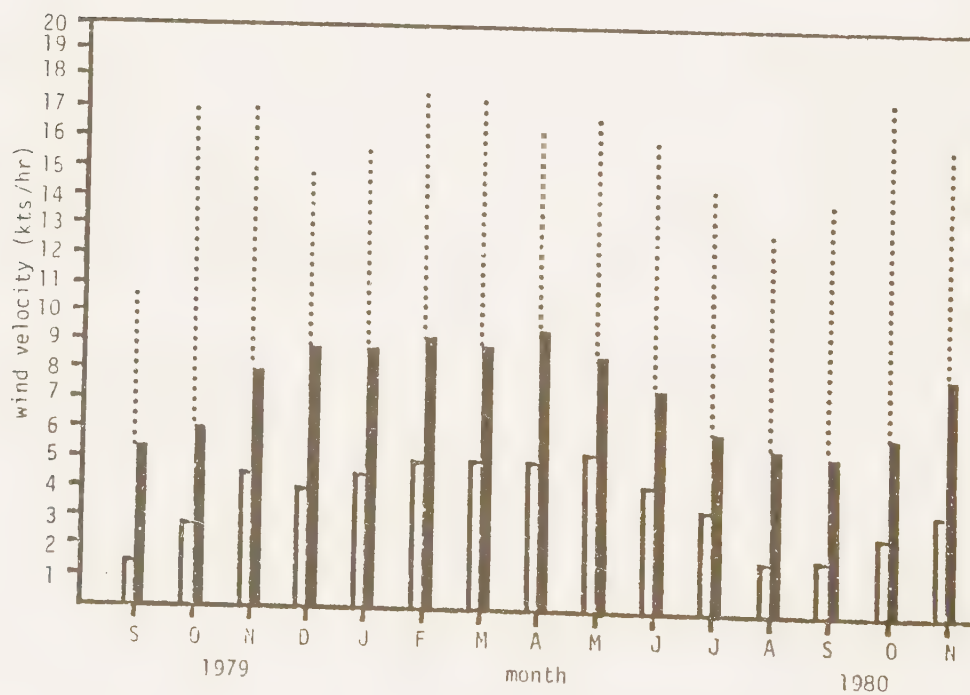


Figure 3. Monthly windspeed on the island of Guam.
 = actual $\bar{x}$ maximum sustained high-hour wind velocity;
 □ = actual $\bar{x}$ wind velocity
 ■ = expected $\bar{x}$ wind velocity.

Estimates of the annual variability in fish species abundance between consecutive years were calculated for the most ubiquitous species group according to the method of Wolda (1978). The formula is as follows:

$$\log R = \log N_i - \log N_{i-1}$$

where, N_i equals the number of individuals of a species counted during a particular month in 1980,

N_{i-1} equals the number of individuals of the same species counted in the same month in 1979,

and, R , the net reproductive rate (Andrewartha and Birch 1954) or the gradation coefficient (Benedek 1970), equals a ratio expressing the change in abundance from one year to the next.

Log R 's were computed individually for the most ubiquitous species and averaged to provide an estimate of the average net change in species abundance ($\bar{R}$) for the group as a whole. The magnitude of this change was estimated by the variance of the log R 's and is expressed as annual variability (AV) (Wolda 1978) in numbers of fish per species between consecutive years. If nearly as many species increased as decreased in abundance between years, R would have a value near zero; and, if the magnitude of these increases or decreases was small, AV would also be relatively low.

Values of AV were calculated for each study site based on the most ubiquitous species counts which were lumped across depths. AV's were computed separately for the site-specific September, October and November data and were averaged to give a mean value per site (1600 m² of reef). Annual variability (AV) at each depth was calculated using the same 35 species by lumping the data from both sites and computing separate values for September, October and November. The resulting values of AV were averaged across months to obtain mean values per depth (800 m² of reef).

Annual variation in species composition within the most ubiquitous species group was estimated for each transect depth and study site by two commonly used similarity indices. These include the following:

$$1) \quad J = \frac{a}{a + b + c}$$

where a equals the number of species recorded during a particular month in both 1979 and 1980,

b equals the number of species recorded during that month in 1980, but not during that month in 1979,

and c equals the number of species recorded during that month in 1979, but not during that month in 1980 (Sokal and Sneath 1963); and

$$2) R = \frac{C}{T_1} + \frac{C}{T_2} \times 0.5$$

where C equals the number of species recorded during a particular month in both 1979 and 1980,

T_1 equals the number of species recorded during that month in 1979,

and T_2 equals the number of species recorded during the that month in 1980 (Smith 1973).

RESULTS

Seasonal Variation

All fish species counted during the study are listed by site and depth in Tables 1 and 2. An increase in overall fish abundance occurred at all depths during the spring and summer months, with maximum monthly counts recorded in May, June and July (Fig. 4). Although there were some variations in these seasonal trends at each depth at the two survey areas, in general the patterns at Asan and Ipao were similar (Fig. 5). Most of the observed seasonal increase in fish abundance is primarily attributable to a relatively small group of species which are well represented at each station (Table 3). In every case, however, other important but less abundant species also contributed to the overall fluctuations.

An examination of the 35 most ubiquitous species revealed a bimodal pattern of seasonal peak abundance. More of these ubiquitous species peaked in May and November than in any of the other months. Also, the majority of the May peaks (57%) occurred at 18 and 30 m, while 71% of the November peaks were recorded at 5 and 9 m. Nineteen of the ubiquitous species were assigned to a general carnivore group which included planktivores, piscivores and benthic invertebrate-feeders; nine were listed as herbivores; and seven were categorized as omnivores (Table 4). Within the carnivore group, 13 species were observed to peak in abundance at either 18 or 30 m (Table 5). Not surprisingly, most of the herbivores peaked at 5 and 9 m, while the recorded peak abundances among the omnivores were almost equally distributed. The monthly fluctuations in numbers of peaking species per trophic category strongly suggests a temporal partition in peak abundance between carnivore and herbivore groups (Fig. 6). When the carnivore and herbivore groups were expanded to include 28 species apiece, the resulting overall pattern in temporal partitioning remained just as strong (Fig. 7).

Although the relationships were less clear at 5 m, fluctuations in overall fish abundance (Fig. 4) seemed to be positively correlated with rainfall (Fig. 2) and negatively correlated with windspeed (Fig. 3). The expanded carnivore and herbivore data were tested to see if rainfall might be a factor influencing the timing of the observed peak abundances. While the combined fish abundance of both trophic categories was significantly greater (chi-square for a 2 X 2 contingency table, $p < 0.01$) during the wet season, it was fishes within the expanded herbivore group that were the major

Table 1. Fish species seen on Asan Pt. transects from September 1979 through November 1980. * = seen only on Asan Pt. transects.

FAMILY/SPECIES	DEPTH (m)			
	5	9	18	30
ACANTHURIDAE (Surgeonfishes)				
<u>Acanthurus glaucoparietus</u> Cuvier	X	X	X	X
<u>A. lineatus</u> (Linnaeus)	X			
<u>A. mata</u> Cuvier	X	X	X	
<u>A. nigrofuscus</u> (Forsskal)	X	X	X	X
<u>A. olivaceus</u> Bloch & Schneider		X	X	X
<u>A. pyroferus</u> Kittlitz			X	X
<u>A. triostegus</u> (Linnaeus)	X	X		
<u>Ctenochaetus striatus</u> (Quoy & Gaimard)	X	X	X	
<u>Naso brevirostris</u> (Valenciennes)			X	X
<u>N. hexacanthus</u> (Bleeker)				X
<u>N. lituratus</u> (Bloch & Schneider)	X	X	X	X
* <u>Paracanthurus hepatus</u> (Linnaeus)		X	X	
<u>Zebrasoma flavescens</u> (Bennett)		X	X	X
<u>Z. veliferum</u> (Bloch)			X	
APOGONIDAE (Cardinalfishes)				
* <u>Apogon novemfasciatus</u> Cuvier			X	
<u>Cheilodipterus quinquelineatus</u> (Cuvier)				X
AULOSTOMIDAE (Trumpetfishes)				
<u>Aulostomus chinensis</u> (Linnaeus)	X			X
BALISTIDAE (Triggerfishes)				
<u>Balistapus undulatus</u> (Park)		X	X	X
<u>Balistoides conspicillum</u> (Bloch & Schneider)	X		X	X
* <u>B. viridescens</u> (Bloch & Schneider)			X	X
<u>Melichthys vidua</u> (Solander)	X	X	X	X
* <u>Odonus niger</u> (Ruppell)			X	
<u>Pseudobalistes flavomarginatus</u> (Ruppell)			X	
* <u>Rhinecanthus echarpe</u> (Lacepede)	X			
<u>Sufflamen bursa</u> (Bloch & Schneider)	X	X	X	X
<u>S. chrysopterus</u> (Bloch & Schneider)	X	X	X	
BLENNIIDAE (Blennies)				
<u>Aspidontis taeniatus</u> (Quoy & Gaimard)		X		
<u>Ecsenius bicolor</u> (Day)	X	X	X	
<u>Meiacanthus atrodorsalis</u> (Gunther)	X		X	X
<u>Plagiotremus tapeinosoma</u> (Bleeker)	X	X	X	

FAMILY/SPECIES	DEPTH (m)			
	5	9	18	30
CARACANTHIDAE (Velvetfishes)				
* <u>Caracanthus maculatus</u> (Gray)		X		
CARANGIDAE (Jacks, Pompanos)				
* <u>Caranx melampygus</u> Cuvier		X		
CHAETODONTIDAE (Butterflyfishes)				
<u>Chaetodon auriga</u> Forsskal	X			
<u>C. citrinellus</u> Cuvier	X	X	X	
<u>C. ephippium</u> Cuvier		X		
<u>C. lunula</u> (Lacepede)	X			X
<u>C. mertensii</u> Cuvier			X	X
<u>C. ornatissimus</u> Cuvier	X			
<u>C. punctatofasciatus</u> Cuvier	X	X	X	X
<u>C. reticulatus</u> Cuvier	X	X	X	
<u>C. trifasciatus</u> Park		X		X
<u>C. ulietensis</u> Cuvier			X	X
<u>C. unimaculatus</u> Bloch		X		
<u>Forcipiger flavissimus</u> Jordan & McGregor	X	X		X
<u>F. longirostris</u> (Broussonet)				X
<u>Hemitaurichthys polylepis</u> (Bleeker)				X
<u>Heniochus chrysostomus</u> Cuvier		X	X	
* <u>H. singularis</u> Smith & Radcliffe			X	
<u>Megaprotodon trifascialis</u> (Quoy & Gaimard)				X
CIRRHITIDAE (Hawkfishes)				
<u>Cirrhitichthys falco</u> Randall		X	X	X
<u>Neocirrhites armatus</u> Castelnau		X		
<u>Paracirrhites arcatus</u> (Cuvier)	X	X	X	
<u>P. forsteri</u> (Bloch & Schneider)	X	X	X	
GOBIIDAE (Gobies)				
<u>Nemateleotris magnifica</u> Fowler		X	X	X
<u>Pogonoculius zebra</u> Fowler	X	X		
<u>Ptereleotris evides</u> (Jordan & Hubbs)	X		X	
<u>Valenciennesa strigatus</u> (Broussonet)	X	X	X	X
HOGLOCENTRIDAE (Squirrelfishes)				
<u>Adioryx caudimaculatus</u> (Ruppell)				X
<u>Flammeo sammara</u> (Forsskal)				X

FAMILY/SPECIES	DEPTH (m)			
	5	9	18	30
LABRIDAE (Wrasses)				
<u>Anampses caeruleopunctatus</u> Ruppell	X			
<u>A. meleagrides</u> Valenciennes			X	X
<u>A. twisti</u> (Bleeker)		X		
<u>Bodianus axillaris</u> (Bennett)				X
<u>Cheilinus chlorourus</u> (Bloch)			X	X
<u>C. fasciatus</u> (Bloch)	X		X	X
<u>C. unifasciatus</u> Gunther	X	X	X	X
<u>C. trilobatus</u> Lacepede	X	X	X	X
<u>C. undulatus</u> Ruppell		X		
<u>Cirrhilabrus</u> sp.	X	X	X	X
<u>Coris gaimard</u> (Quoy & Gaimard)		X	X	X
<u>Epibulus insidiator</u> (Pallas)	X	X	X	X
<u>Gomphosus varius</u> Lacepede	X	X		X
<u>Halichoeres biocellatus</u> Schultz			X	X
<u>H. hortulanus</u> (Lacepede)	X	X		X
<u>H. margaritaceus</u> (Valenciennes)	X	X		
<u>H. marginatus</u> Ruppell	X	X	X	
<u>H. sp.</u>			X	
<u>Hemigymnus melapterus</u> (Bloch)	X	X		X
<u>Hologymnosus doliatus</u> (Lacepede)	X	X	X	X
<u>Labroides bicolor</u> Fowler & Bean	X	X		X
<u>L. dimidiatus</u> (Valenciennes)	X	X	X	X
<u>Labropsis micronesica</u> Randall		X		
<u>L. xanthonotus</u> Randall			X	X
<u>Macropharyngodon meleagris</u> (Valenciennes)		X	X	X
* <u>Novaculichthys taeniourus</u> (Lacepede)		X	X	
<u>Pseudocheilinus evanidus</u> Jordan & Evermann		X	X	X
<u>P. hexataenia</u> (Bleeker)		X	X	
<u>Stethojulis bandanensis</u> (Bleeker)	X	X	X	X
<u>Thalassoma amblycephalum</u> (Bleeker)	X	X		
<u>T. lutescens</u> (Lay & Bennett)	X	X	X	X
<u>T. quinquevittatum</u> (Lay & Bennett)	X	X		
* <u>Labrid</u> sp. 1	X			
* <u>Labrid</u> sp. 2			X	
LETHRINIDAE (Emperors)				
* <u>Monotaxis grandoculis</u> (Forsskal)				X
LUTJANIDAE (Snappers)				
* <u>Lutjanus bohar</u> (Forsskal)				X
* <u>L. rivulatus</u> (Cuvier & Valenciennes)				X

FAMILY/SPECIES	DEPTH (m)			
	5	9	18	30
<u>C. traceyi</u> (Woods & Schultz)	X			
<u>Dascyllus reticulatus</u> (Richardson)	X	X	X	
<u>D. trimaculatus</u> (Ruppell)	X		X	
<u>Plectroglyphidodon dickii</u> (Lienard)	X	X		
* <u>P. imparipennis</u> (Valliant & Sauvage)	X			
<u>P. johnstonianus</u> Fowler & Ball	X	X	X	
<u>P. lacrymatus</u> (Quoy & Gaimard)		X	X	X
<u>Pomacentrus vaiuli</u> Jordon & Seale	X	X	X	X
<u>Pomachromis guamensis</u> Allen & Larson	X	X	X	X
<u>Stegastes fasciolatus</u> (Ogilby)	X	X		

SCARIDAE (Parrotfishes)

* <u>Bolbometopon muricatus</u> (Valenciennes)	X			
<u>Cetoscarus bicolor</u> (Ruppell)		X	X	
<u>Scarus brevifilis</u> (Gunther)	X	X		
<u>S. ghobban</u> Forsskal				X
<u>S. gibbus</u> Ruppell		X	X	
* <u>S. oviceps</u> Valenciennes		X	X	
<u>S. psittacus</u> Forsskal	X	X	X	X
<u>S. rubroviolaceus</u> (Bleeker)	X	X	X	
<u>S. schlegeli</u> (Bleeker)	X	X	X	X
<u>S. sordidus</u> Forsskal	X	X	X	X

SCORPAENIDAE (Scorpionfishes)

* <u>Synanceia verrucosa</u> Bloch & Schneider			X	
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SERRANIDAE (Groupers)

* <u>Cephalopholis argus</u> (Bloch & Schneider)				X
<u>C. urodelus</u> (Bloch & Schneider)	X	X	X	X
<u>Epinephelus fasciatus</u> (Forsskal)		X	X	X
* <u>Plectropomus melanoleucus</u> (Lacepede)				X
<u>Variola louti</u> (Forsskal)				X

SIGANIDAE (Rabbitfishes)

<u>Siganus argenteus</u> (Quoy & Gaimard)			X	X
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SYNODONTIDAE (Lizardfishes)

<u>Synodus variegatus</u> (Lacepede)		X	X	X
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FAMILY/SPECIES		DEPTH (m)			
		5	9	18	30
TETRAODONTIDAE (Smooth Puffers)					
<u>Arothron nigropunctatus</u> (Bloch & Schneider)			X		
<u>Canthigaster bennetti</u> (Bleeker)	X				X
<u>C. coronata</u> (Valliant & Sauvage)				X	
<u>C. janthinoptera</u> (Bleeker)			X		
<u>C. solandri</u> (Richardson)	X	X	X	X	X
<u>C. valentini</u> (Bleeker)				X	
ZANCLIDAE (Moorish Idols)					
<u>Zanclus cornutus</u> (Linnaeus)		X	X	X	X
Total No. Families	29	17	21	21	23
Total No. Species	155	78	92	96	80

FAMILY/SPECIES	DEPTH (m)			
	5	9	18	30
MALACANTHIDAE (False Whittings)				
* <u>Malacanthus brevirostris</u> Guichenot			X	
MONACANTHIDAE (Filefishes)				
* <u>Cantherhines dumerili</u> (Hollard)			X	
<u>C. pardalis</u> (Ruppell)	X	X	X	
<u>Paraluteres prionurus</u> Bleeker			X	
<u>P. melanocephalus</u> (Bleeker)		X	X	
MUGILOIDIDAE (Sand Perches)				
<u>Parapercis clathrata</u> Ogilby	X	X	X	X
MULLIDAE (Goatfishes)				
<u>Mulloidichthys flavolineatus</u> (Lacepede)	X			
<u>Parupeneus bifasciatus</u> (Lacepede)	X		X	X
<u>P. chryserydros</u> (Lacepede)	X	X	X	X
<u>P. pleurostigma</u> (Bennett)	X		X	X
<u>P. trifasciatus</u> (Lacepede)	X	X	X	X
MURAENIDAE (Moray Eels)				
* <u>Lycodontis richardsoni</u> (Bleeker)		X		
OSTRACIONTIDAE (Boxfishes, Cowfishes)				
<u>Ostracion meleagris</u> Shaw		X		X
POMACANTHIDAE (Angelfishes)				
<u>Apolemichthys trimaculatus</u> (Cuvier)	X	X	X	
* <u>Centropyge bicolor</u> Bloch	X			
<u>C. flavissimus</u> (Cuvier)	X	X	X	
<u>C. heraldi</u> Woods & Schultz			X	X
<u>C. shepardi</u> Randall & Yasuda			X	X
<u>Pygoplites diacanthus</u> (Boddaert)			X	X
POMACENTRIDAE (Damsel-fishes)				
<u>Amphiprion clarkii</u> (Bennett)		X	X	
<u>Chromis acares</u> Pandall & Swerdloff		X		
<u>C. amboinensis</u> (Bleeker)			X	
<u>C. margaritifera</u> Fowler	X	X		
<u>Chrysiptera leucopomus</u> (Lesson)	X	X		

Table 2. Fish species seen on Ipao Pt. transects from September 1979 through November 1980. * = seen only on Ipao Pt. transects.

FAMILY/SPECIES	DEPTH (m)			
	5	9	18	30
ACANTHURIDAE (Surgeonfishes)				
<u>Acanthurus glaucopariens</u> Cuvier	X	X	X	X
<u>A. lineatus</u> (Linnaeus)	X	X		
<u>A. mata</u> Cuvier		X		
<u>A. nigrofusus</u> (Forsskal)	X	X	X	X
<u>A. olivaceus</u> Bloch & Schneider			X	
<u>A. pyroferus</u> Kittlitz	X	X	X	X
<u>A. triostegus</u> (Linnaeus)	X			
<u>Ctenochaetus binotatus</u> Randall			X	
<u>C. striatus</u> (Quoy & Gaimard)	X	X	X	X
<u>Naso annulatus</u> (Quoy & Gaimard)		X		
<u>N. brevirostris</u> (Valenciennes)	X	X	X	X
<u>N. hexacanthus</u> (Bleeker)				X
<u>N. lituratus</u> (Bloch & Schneider)	X	X	X	X
* <u>N. unicornis</u> (Forsskal)	X	X	X	X
* <u>N. vlamingi</u> (Valenciennes)				X
<u>Zebrasoma flavescens</u> (Bennett)			X	X
<u>Z. veliferum</u> (Bloch)			X	X
APOGONIDAE (Cardinalfishes)				
* <u>Apogon</u> sp.				X
<u>Cheilodipterus quinquelineatus</u> (Cuvier)		X		
* <u>C. macrodon</u> (Lacepede)			X	X
AULOSTOMIDAE (Trumpetfishes)				
<u>Aulostomus chinensis</u> (Linnaeus)	X	X	X	X
BALISTIDAE (Triggerfishes)				
<u>Balistapus undulatus</u> (Park)	X	X	X	X
<u>Balistoides conspicillum</u> (Bloch & Schneider)			X	
<u>Melichthys vidua</u> (Solander)	X	X	X	X
<u>Pseudobalistes flavomarginatus</u> (Ruppell)	X			
* <u>Rhinecanthus aculeatus</u> (Linnaeus)				X
<u>Sufflamen bursa</u> (Bloch & Schneider)	X	X	X	X
<u>S. chrysopterus</u> (Bloch & Schneider)	X	X	X	X
BLENNIIDAE (Blennies)				
<u>Aspidontis taeniatus</u> (Quoy & Gaimard)		X		
<u>Ecsenius bicolor</u> (Day)		X	X	
* <u>Exallias brevis</u> (Kner)	X	X		
<u>Meiacanthus atrodorsalis</u> (Cunther)	X	X	X	X

FAMILY/SPECIES	DEPTH (m)			
	5	9	18	30
<u>Plagiotremus tapeinosoma</u> (Bleeker)	X	X		
* <u>Blenniid</u> sp.	X			
CAESIONIDAE (Fusiliers)				
* <u>Pterocaesio chrysozonus</u> (Cuvier)			X	X
CHAETODONTIDAE (Butterflyfishes)				
<u>Chaetodon auriga</u> Forsskal	X	X	X	X
* <u>C. bennetti</u> Cuvier				X
<u>C. citrinellus</u> Cuvier	X	X	X	X
<u>C. ephippium</u> Cuvier	X	X	X	X
<u>C. lunula</u> (Lacepede)	X			X
* <u>C. kleini</u> Bloch			X	
* <u>C. lineolatus</u> Cuvier		X	X	
<u>C. lunula</u> Lacepede	X	X	X	
<u>C. mertensii</u> Cuvier			X	X
<u>C. ornatissimus</u> Cuvier	X	X	X	
<u>C. punctatofasciatus</u> Cuvier		X	X	X
* <u>C. quadrimaculatus</u> Gray	X	X		
<u>C. reticulatus</u> Cuvier	X	X	X	X
<u>C. trifasciatus</u> Park	X	X	X	X
<u>C. ulietensis</u> Cuvier		X	X	X
<u>C. unimaculatus</u> Bloch	X	X		X
* <u>C. vagabundus</u> Linnaeus				X
<u>Forcipiger flavissimus</u> Jordan & McGregor	X	X	X	X
<u>F. longirostris</u> (Broussonet)				X
<u>Hemitaurichthys polylepis</u> (Bleeker)			X	
<u>Heniochus chrysostomus</u> Cuvier		X	X	X
<u>Megaprotodon trifascialis</u> (Quoy & Gaimard)	X	X	X	X
CIRRHITIDAE (Hawkfishes)				
<u>Cirrhitichthys falco</u> Randall		X	X	
<u>Neocirrhites armatus</u> Castelnau	X	X	X	
<u>Paracirrhites arcatus</u> (Cuvier)	X	X	X	
<u>P. forsteri</u> (Bloch & Schneider)	X	X	X	
FISTULARIIDAE (Coronetfishes)				
* <u>Fistularia commersonii</u> Ruppell		X		
GOBIIDAE (Gobies)				
<u>Nemateleotris magnifica</u> Fowler		X	X	X
<u>Pogonoculius zebra</u> Fowler	X	X		
<u>Ptereleotris evides</u> (Jordan & Hubbs)	X	X	X	
<u>Valenciennesa strigatus</u> (Broussonet)	X	X		

FAMILY/SPECIES	DEPTH (m)			
	5	9	18	30
HOLOCENTRIDAE (Squirrelfishes)				
<u>Adioryx caudimaculatus</u> (Ruppell)		X	X	X
* <u>A. spinifer</u> (Forsskal)			X	
<u>Flammeo sammara</u> (Forsskal)			X	
* <u>Myrpristis</u> sp.	X		X	X
KYPHOSIDAE (Rudderfishes)				
* <u>Kyphosus cinerascens</u> (Forsskal)			X	
LABRIDAE (Wrasses)				
<u>Anampses caeruleopunctatus</u> Ruppell	X	X	X	X
<u>A. meleagrides</u> Valenciennes	X			
<u>A. twisti</u> (Bleeker)	X	X	X	X
<u>Bodianus axillaris</u> (Bennett)	X	X	X	X
<u>Cheilinus chlorourus</u> (Bloch)	X	X	X	X
<u>C. fasciatus</u> (Bloch)	X			X
<u>C. unifasciatus</u> Gunther	X	X	X	X
<u>C. trilobatus</u> Lacepede	X	X	X	X
<u>C. undulatus</u> Ruppell				X
* <u>Cheilio inermis</u> (Forsskal)	X			
<u>Cirrhitilabrus</u> sp.	X	X	X	X
<u>Coris gaimard</u> (Quoy & Gaimard)		X	X	X
<u>Epibulus insidiator</u> (Pallas)	X	X	X	X
<u>Gomphosus varius</u> Lacepede	X	X	X	
<u>Halichoeres biocellatus</u> Schultz	X		X	X
<u>H. hortulanus</u> (Lacepede)	X	X	X	X
<u>H. margaritaceus</u> (Valenciennes)	X	X		
<u>H. marginatus</u> Ruppell	X	X	X	X
<u>H. sp.</u>		X	X	
<u>Hemigymnus melapterus</u> (Bloch)	X		X	
<u>Hologymnosus doliatus</u> (Lacepede)			X	
<u>Labroides bicolor</u> Fowler & Bean	X	X	X	
<u>L. dimidiatus</u> (Valenciennes)	X	X	X	X
<u>Labropsis micronesica</u> Randall			X	
<u>L. xanthonotus</u> Randall	X		X	
<u>Macropharyngodon meleagris</u> (Valenciennes)	X	X	X	
<u>Pseudocheilinus evanidus</u> Jordan & Evermann			X	X
<u>P. hexataenia</u> (Bleeker)			X	X
<u>Stethojulis bandanensis</u> (Bleeker)	X	X	X	X
<u>Thalassoma amblycephalum</u> (Bleeker)	X	X		
* <u>T. fuscum</u> (Lacepede)		X		
<u>T. lutescens</u> (Lay & Bennett)	X	X	X	
<u>T. quinquevittatum</u> (Lay & Bennett)	X	X	X	
* <u>Labrid</u> sp. 3		X		

FAMILY/SPECIES	DEPTH (m)			
	5	9	18	30
* <u>Labrid</u> sp. 4				X
* <u>Labrid</u> sp. 5		X		
LETHRINIDAE (Emperors)				
* <u>Gnathodentex aureolineatus</u> (Lacepede)	X		X	
* <u>Lethrinus semicinctus</u> Valenciennes			X	
LUTJANIDAE (Snappers)				
* <u>Lutjanus fulvus</u> (Bloch & Schneider)		X		
* <u>L.</u> sp.				X
* <u>Macolor niger</u> (Forsskal)		X		
MONACANTHIDAE (Filefishes)				
* <u>Amanses scopas</u> (Cuvier)	X	X		
<u>Cantherhines pardalis</u> (Ruppell)	X	X		
* <u>Oxymonacanthus longirostris</u> (Bloch & Schneider)		X	X	X X
<u>Paraluteres prionurus</u> Bleeker		X		
<u>P. melanocephalus</u> (Bleeker)	X	X	X	
MUGILOIDIDAE (Sand Perches)				
<u>Parapercis clathrata</u> Ogilby	X	X	X	X
MULLIDAE (Goatfishes)				
<u>Mulloidichthys flavolineatus</u> (Lacepede)	X		X	X
* <u>Parupeneus barberinus</u> (Lacepede)				X
<u>P. bifasciatus</u> (Lacepede)	X	X	X	X
<u>P. chryserydros</u> (Lacepede)	X	X	X	X
<u>P. pleurostigma</u> (Bennett)		X		X
<u>P. trifasciatus</u> (Lacepede)	X	X	X	X
MURAENIDAE (Moray Eels)				
* <u>Gymnothorax</u> sp.				X
OSTRACIONTIDAE (Boxfishes, Cowfishes)				
* <u>Ostracion cubicus</u> Linnaeus	X	X		
<u>O. meleagris</u> Shaw	X	X	X	X
PEMPHERIDAE (Sweepers)				
* <u>Pempheris oualensis</u> Cuvier		X	X	X

FAMILY/SPECIES	DEPTH (m)			
	5	9	18	30
POMACANTHIDAE (Angelfishes)				
<u>Apolemichthys trimaculatus</u> (Cuvier)		X		
<u>C. flavissimus</u> (Cuvier)	X	X	X	X
<u>C. heraldi</u> Woods & Schultz	X		X	X
<u>C. shepardi</u> Randall & Yasuda			X	X
* <u>Pomacanthus imperator</u> (Bloch)	X			
<u>Pygoplites diacanthus</u> (Boddaert)	X	X	X	X
POMACENTRIDAE (Damselfishes)				
<u>Amphiprion clarkii</u> (Bennett)	X	X	X	
<u>Chromis acares</u> Randall & Swerdloff	X	X		
* <u>C. agilis</u> Smith			X	X
<u>C. amboinensis</u> (Bleeker)			X	X
<u>C. margaritifer</u> Fowler	X	X		
<u>Chrysiptera leucopomus</u> (Lesson)	X	X		
<u>C. traceyi</u> (Woods & Schultz)	X	X	X	X
* <u>Dascyllus aruanus</u> (Linnaeus)	X			
<u>D. reticulatus</u> (Richardson)	X	X	X	X
<u>D. trimaculatus</u> (Ruppell)			X	X
<u>Plectroglyphidodon dickii</u> (Lienard)	X	X		
<u>P. johnstonianus</u> Fowler & Ball	X	X	X	
<u>P. lacrymatus</u> (Quoy & Gaimard)	X		X	
<u>Pomacentrus vaiuli</u> Jordon & Seale	X	X	X	X
<u>Pomachromis guamensis</u> Allen & Larson	X	X		
<u>Stegastes fasciolatus</u> (Ogilby)	X	X		
SCARIDAE (Parrotfishes)				
* <u>Calotomus sandwichensis</u> (Valenciennes)			X	
<u>Cetoscarus bicolor</u> (Ruppell)	X	X		
* <u>Hipposcarus longiceps</u> (Valenciennes)			X	
<u>Scarus brevifilis</u> (Gunther)	X	X	X	X
<u>S. ghobban</u> Forsskal	X	X	X	
<u>S. gibbus</u> Ruppell	X		X	
<u>S. psittacus</u> Forsskal	X	X	X	X
<u>S. rubroviolaceus</u> (Bleeker)	X	X	X	
<u>S. schlegeli</u> (Bleeker)	X	X	X	X
<u>S. sordidus</u> Forsskal	X	X	X	X
* <u>S. tricolor</u> Bleeker			X	X
* <u>Scarid</u> sp.				X
SERRANIDAE (Groupers)				
<u>Cephalopholis urodelus</u> (Bloch & Schneider)	X	X	X	
<u>Epinephelus fasciatus</u> (Forsskal)		X		X

FAMILY/SPECIES		DEPTH (m)			
		5	9	18	30
* <u>E. merra</u> Bloch				X	X
<u>Variola louti</u> (Forsskal)					X
SIGANIDAE (Rabbitfishes)					
<u>Siganus argenteus</u> (Quoy & Gaimard)				X	X
SYNODONTIDAE (Lizardfishes)					
* <u>Synodus gracilis</u> (Quoy & Gaimard)					X
<u>Synodus variegatus</u> (Lacepede)			X	X	X
TETRAODONTIDAE (Smooth Puffers)					
<u>Arothron nigropunctatus</u> (Bloch & Schneider)				X	X
<u>Canthigaster bennetti</u> (Bleeker)			X	X	
<u>C. coronata</u> (Valliant & Sauvage)					X
<u>C. janthinoptera</u> (Bleeker)		X	X		
<u>C. solandri</u> (Richardson)		X	X	X	X
<u>C. valentini</u> (Bleeker)		X	X	X	
ZANCLIDAE (Moorish Idols)					
<u>Zanclus cornutus</u> (Linnaeus)		X	X	X	X
Total No. Families	29	21	23	26	25
Total No. Species	176	105	114	117	97

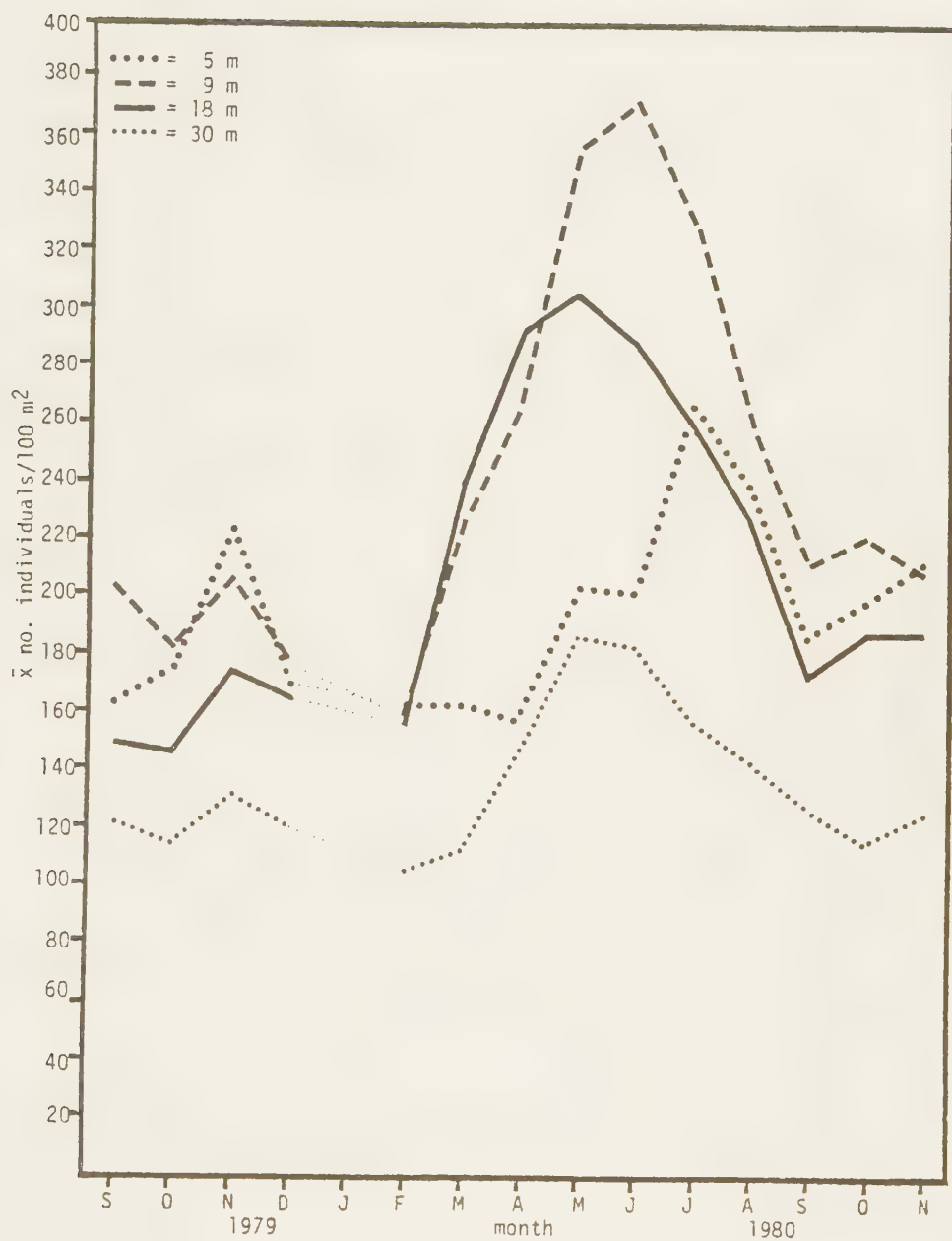


Figure 4. Monthly fluctuations in overall fish abundance (mean number of individuals/100 m²) recorded from September 1979 through November 1980 by depth.

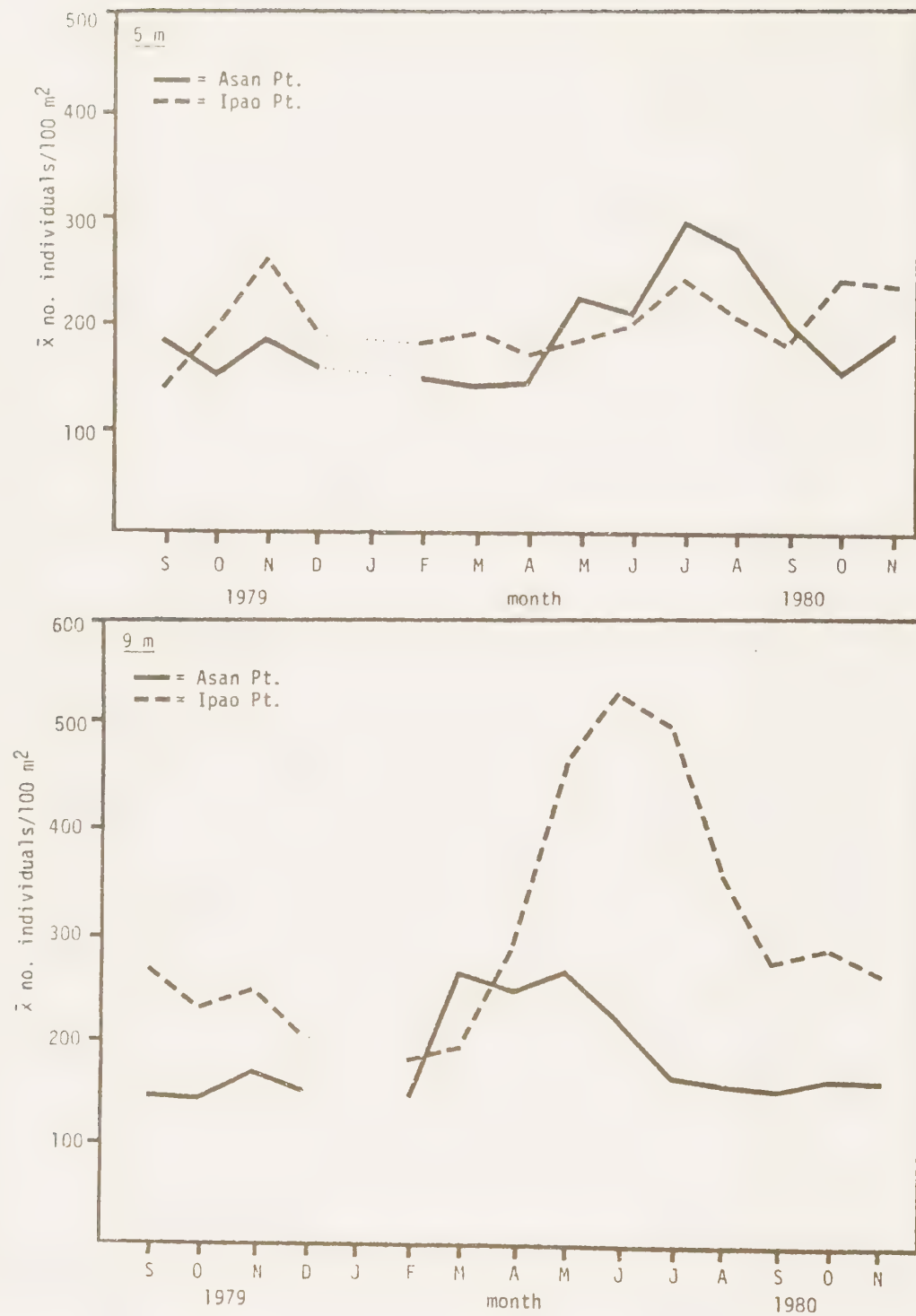


Figure 5. Monthly fluctuations in fish abundance (mean numbers of individuals/100 m²) recorded at each depth by study site.

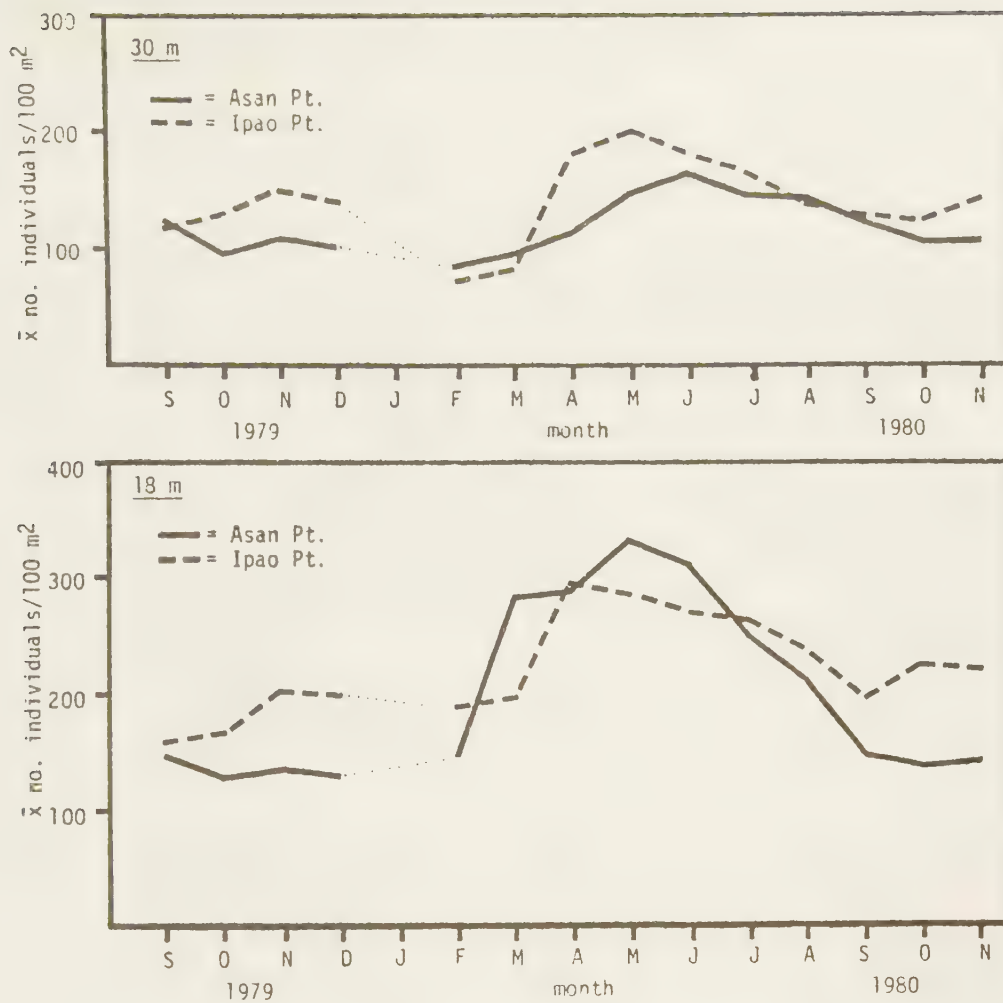


Figure 5. Continued.

Table 3. Most influentially abundant fish species (≥ 500 individuals) counted at each transect station during the entire study. Numbers equal total number counted at a particular station.

ASAN PT.		IPAO PT.	
<u>5 m:</u>		<u>5 m:</u>	
<u>Chrysiptera leucopomus</u>	2780	<u>Stegastes fasciolatus</u>	3584
<u>Thalassoma quinquevittatum</u>	2095	<u>Plectroglyphidodon dickii</u>	2607
<u>Plagiotremus tapeinosoma</u>	613	<u>T. quinquevittatum</u>	842
<u>Ctenochaetus striatus</u>	549	<u>Acanthurus nigrofuscus</u>	675
<u>9 m:</u>		<u>9 m:</u>	
<u>Pomachromis guamensis</u>	4439	<u>P. guamensis</u>	2133
<u>Dascyllus reticulatus</u>	3044	<u>S. fasciolatus</u>	1480
<u>T. quinquevittatum</u>	1636	<u>T. quinquevittatum</u>	969
<u>Cirrhilabrus sp.</u>	1495	<u>D. reticulatus</u>	794
<u>S. fasciolatus</u>	1261	<u>Pomacentrus vaiuli</u>	685
<u>Plectroglyphidodon johnstonianus</u>	921	<u>P. johnstonianus</u>	568
<u>A. nigrofuscus</u>	535	<u>A. nigrofuscus</u>	524
<u>18 m:</u>		<u>18 m:</u>	
<u>Cirrhilabrus sp.</u>	3123	<u>Chrysiptera traceyi</u>	3014
<u>D. reticulatus</u>	2668	<u>Plectroglyphidodon lacrymatus</u>	2219
<u>P. guamensis</u>	1127	<u>P. vaiuli</u>	2140
<u>P. vaiuli</u>	805	<u>A. nigrofuscus</u>	629
<u>30 m:</u>		<u>30 m:</u>	
<u>P. vaiuli</u>	2598	<u>C. traceyi</u>	4504
<u>C. traceyi</u>	1237	<u>P. vaiuli</u>	734

Total No. Species = 14

Table 4. General trophic categories to which the members of the most ubiquitous species group were assigned. Species are listed in decreasing order of total abundance relative to each category.

<u>CARNIVORES</u>	<u>HERBIVORES</u>	<u>OMNIVORES</u>
<u>Cirrhilabrus sp.</u>	<u>Acanthurus nigrofuscus</u>	<u>Pomacentrus vaiuli</u>
<u>Meicanthus atrodorsalis</u>	<u>Scarus sordidus</u>	<u>Dascyllus reticulatus</u>
<u>Parupeneus trifasciatus</u>	<u>Ctenochaetus striatus</u>	<u>Chaetodon citrinellus</u>
<u>Thalassoma lutescens</u>	<u>Scarus psittacus</u>	<u>Canthigaster solandri</u>
<u>Zanclus cornutus</u>	<u>Scarus schlegeli</u>	<u>Chaetodon</u>
<u>Sufflamen bursa</u>	<u>Naso lituratus</u>	<u>punctatofasciatus</u>
<u>Parapercis clathrata</u>	<u>Acanthurus</u>	<u>Melichthys vidua</u>
<u>Stethojulis bandanensis</u>	<u>glaucoparieus</u>	<u>Balistapus undulatus</u>
<u>Labroides dimidiatus</u>	<u>Chaetodon reticulatus</u>	
<u>Cheilinus unifasciatus</u>	<u>Centropyge flavissimus</u>	
<u>Sufflamen chrysopterus</u>		
<u>Cephalopholis urodelus</u>		
<u>Halichoeres hortulanus</u>		
<u>Forcipiger flavissimus</u>		
<u>Halichoeres marginatus</u>		
<u>Epibulus insidiator</u>		
<u>Cheilinus trilobatus</u>		
<u>Parupeneus bifasciatus</u>		
<u>Parupeneus chryseredros</u>		
No. Species/Group = 19	9	7
Total No. Species = 35		

Table 5. Number of species per general trophic category (within the most ubiquitous species group) that peaked in mean abundance at each transect depth.

<u>Trophic Category</u>	<u>Transect Depth</u>				<u>Total No. Species</u>
	<u>5m</u>	<u>9m</u>	<u>18m</u>	<u>30m</u>	
CARNIVORES	3	3	8	5	19
	32%		68%		
HERBIVORES	6	2	1	0	9
	89%		11%		
OMNIVORES	0	3	1	3	7
	43%		57%		
Total No. Species =	9	8	10	8	35

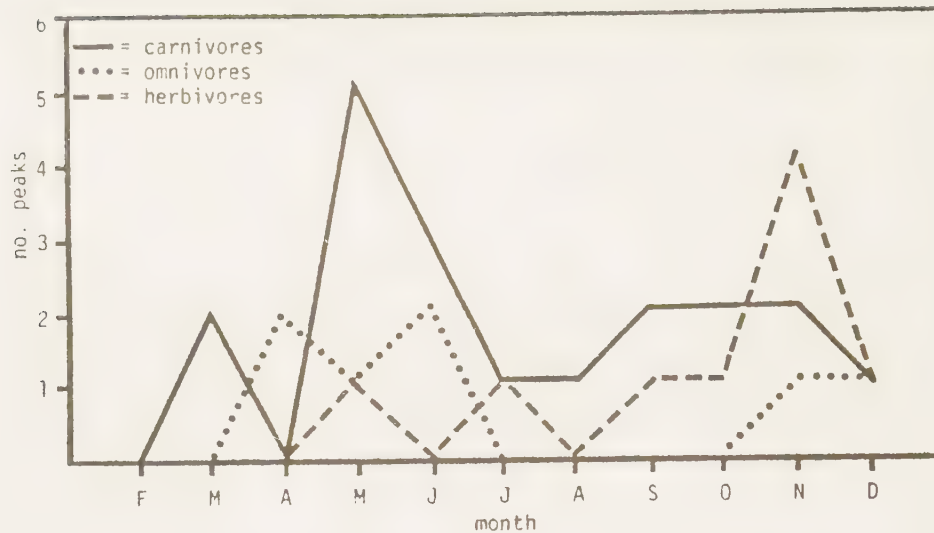


Figure 6. Number of representative peak abundances recorded each month (based on maximum mean monthly counts) among carnivores, herbivores and omnivores within the most ubiquitous species group. Total number of species = 35.

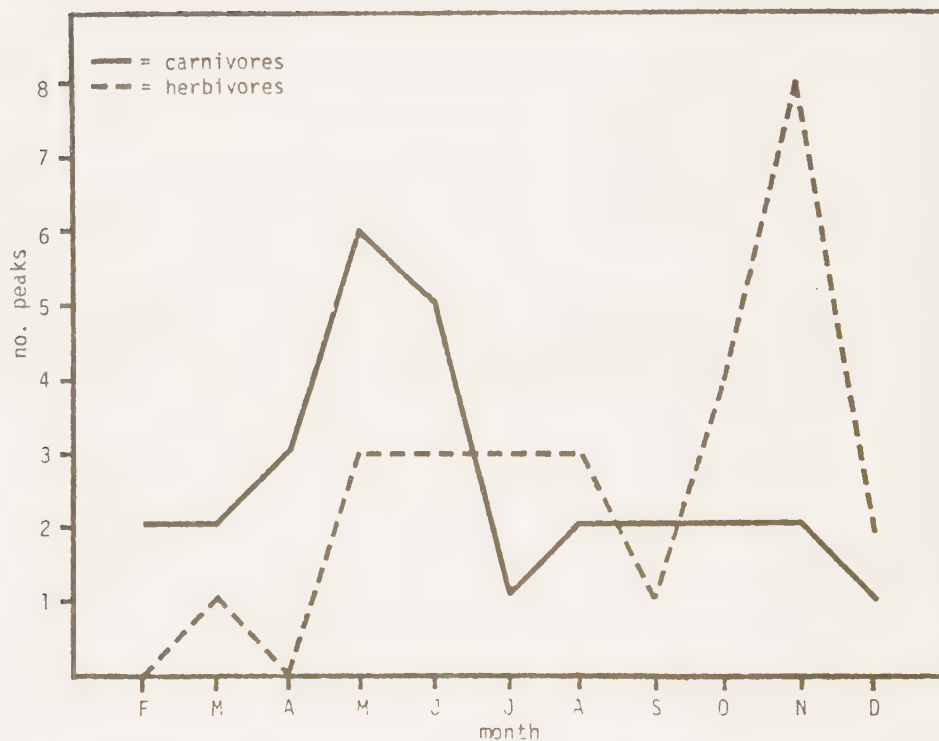


Figure 7. Number of representative peak abundances recorded each month (based on maximum mean monthly counts) among equal numbers of carnivores and herbivores within an expanded ubiquitous species group. Total number of species = 56.

contributors (chi-square for 2 classes, $p < 0.01$) to this increase. Chi-square test for more than two classes also supported (herbivores, $p < 0.05$) this result. When the carnivore and herbivore data were segregated into quarterly intervals, it was found that these periods were not homogeneous (G-statistic [G_H], $p < 0.025$) in their expected ratios of numbers of species peaks per trophic category; and it was the October-December period that was significantly different (G-statistic [G], $p < 0.05$). Therefore, although the combined fish abundance represented by both trophic categories was greatest during the rainy season, the expanded carnivore group increased early and peaked before the month of maximum rainfall, and the expanded herbivore group did not increase significantly until after the rainiest month had passed. Thus, the seasonal fluctuations among the more ubiquitous and abundant fish species appeared to follow a depth-related pattern that was probably related to food resources.

The first species noted to recruit in appreciable numbers during 1980 was the planktivore Pomachromis guamensis, which settled strongly in March at 9 and 18 m. Other relatively abundant plankton-feeders that recruited between March and June included the omnivores Dascyllus reticulatus, Pomacentrus vaiuli, Chrysiptera traceyi and, as juveniles, Cirrhitilabrus sp. Along with other less abundant planktivores, such as Nemateleotris magnifica and Ptereleotris evides, these species probably represented a significant food resource for several piscivores. In fact, maximum mean monthly counts of the groupers, Cephalopholis urodelus and Epinephelus fasciatus, the hawkfishes, Cirrhilichthys falco and Paracirrhites forsteri, the sand perch, Parapercis clathrata, and the wrasses, Cheilinus trilobatus and C. unifasciatus, were all recorded between February and June. Piscivore increases observed during these months were mainly due to the appearances of subadults and adults and additionally included sporadic sightings of larger groupers, snappers and wrasses, such as Variola louti, Lutjanus bohar and Cheilinus undulatus. These latter species are deeper-water predators that may have undergone a seasonal vertical migration in response to increased prey abundance on the upper reef slope (Kock 1982).

Several benthic invertebrate-feeders also exhibited peak abundances during the same period. Increases among these species were primarily due to juvenile recruitment, but older juveniles and adults were also commonly encountered. They included the boxfish, Ostracion meleagris, the triggerfish, Sufflamen bursa and the wrasses, Coris gaimard, Comphosus varius, Halichoeres hortulanus, H. marginatus, Macropharyngodon meleagris, Stethojulis bandanensis and Thalassoma quinquevittatum, amidst others. These species also many have peaked during a time of expanding food resources since the strong planktivore fluctuation suggests the presence of abundant plankton, upon which may benthic invertebrates are known to feed. However, data directly supporting this were not collected during the study.

Of the 14 ubiquitous herbivores that peaked in abundance during the October-December period, eight (Acanthurus lineatus, A. nigrofuscus, A. triostegus, A. pyroferus, Naso lituratus, N. unicornis, Zebrasoma flavescens and Z. veliferum) were browsing and two (Acanthurus mata and Ctenochaetus striatus) were grazing surgeonfishes; two (Scarus brevifilis and S. psittacus) were grazing parrotfishes; and one each (Centropyge

flavissimus and Chaetodon reticulatus) were browsing angelfish and butterflyfish, respectively. Of the ten browsers eight are surgeonfishes that were most abundant at 5 m. Although they were not uncommon, juvenile surgeonfishes seemed generally low in representation on the reef slope. Most of the largest increases in surgeonfish abundance were due to the presence of subadult/adult mixed-species foraging aggregations that appeared to be most numerous and most frequent during the fall. The most conspicuous species included Acanthurus glaucopareis, A. nigrofuscus, A. triostegus, and N. lituratus.

In contrast, the majority of the newly recruited juvenile browsers observed during this study were territorial damselfishes that generally peaked in overall abundance during the spring/summer months on the reef front and upper submarine terrace. The most important of these species included Chrysiptera leucompomus, Stegastes fasciolatus, Plectroglyphidodon dickii, P. lacrymatus and P. johnstonianus. Juvenile parrotfishes were encountered at a rather moderate frequency, often in small groups (10-20 individuals) or as part of larger (100-200 individuals) mixed-species foraging aggregations. However, there were no strong relationships between parrotfish abundance and specific depths or reef zones. S. brevifilis and S. psittacus peaked during the October-December period, while peak abundances were recorded for Cetoscarus bicolor, Scarus rubroviolaceus, S. schlegeli and S. sordidus between May and August. The latter species, however, showed strong increases in the fall, and along with S. psittacus and S. schlegeli often formed substantial portions of foraging aggregations. Since the reef slope algal biomass did not fluctuate noticeably during this study, there seems to be no direct relationship between fluctuations in herbivorous fish abundance and food resources on the upper reef slope. But again, data directly supporting this were not collected during the investigation.

Annual Variation

Annual variation in the counts of the 35 most ubiquitous fish species was estimated with data collected during the months of September, October and November, 1979 and 1980. The counts of these species were lumped across depths and analyzed by site. Values of $\bar{R}$ calculated from the September data showed that net decreases in abundance occurred between years in most species at both sites; but based on the October and November data sets these values showed net increases between years at both sites. Values of AV calculated for these months at both sites were generally low, ranging from 0.06 to 0.17, indicating that relatively little overall change in ranked fish abundances had occurred between years. Within the 1600 m² area surveyed at each site, the most ubiquitous upper reef slope fishes showed fairly comparable abundance rankings from year to year ($\bar{x}$ AV Asan and Ipao = 0.11 and 0.09, respectively).

Annual variation was estimated for each depth by lumping depth-specific data across sites. The mean log R's (R) among months for the 35 ubiquitous species show net decreases to have been prevalent between years in the September data, while net increases are found in the October and November data sets. Comparisons of $\bar{R}$ among depths indicate that the most widespread increases in abundance between years occurred at 18 m. The calculated values of AV range from 0.03 to 0.23, with consistently higher

values at 18 m. Table 6 summarizes the values of $\bar{R}$ and AV calculated for each study site and depth for each pair of months. The results show that on a relatively broader scale of analysis (1600 m² of reef), AV's calculated by site are comparatively low and not very different from each other. Values of AV are generally higher when calculated for specific depths and depth-month combinations (800 m² of reef). The mean value for all depths ($\bar{x}$ AV = 0.13) is similar to that for both study sites ($\bar{x}$ AV = 0.10), indicating low annual variation in abundance over the extensive reef areas analyzed. In addition, trends in the calculated values of AV across depths seem to be loosely correlated with the depth-related trends in observed species richness (Tables 1 and 2).

Yearly changes in species composition among the 35 most ubiquitous species as estimated by the J and R indices of resemblance show the same trend (Tables 7 and 8). Study sites (all depths combined) show greater species constancy (ie., higher index values) than do individual depth zones indicating that species composition is more persistent over broader areas than within narrower zones. The mean values of each index for all depths combined, excluding 30 m, were similar (J = 0.84; R = 0.91) and relatively high, indicating the presence of a fairly constant ubiquitous species composition. Yearly differences in the numbers of species observed at 30 m is misleading since twice the amount of census time was expended at that depth in 1979. Consequently, the 30-m data were not used in computing the mean similarity values.

DISCUSSION

The changes in overall fish abundance observed during this study (Fig. 4) conformed to a general pattern consistent with recent work done in Guam (Kock 1982), Micronesia (Johannes 1978), Hawaii (Watson and Leis 1974), the Caribbean (Luckhurst and Luckhurst 1977) and the Great Barrier Reef (Russell et al. 1977; Talbot et al. 1978; Williams and Sale 1981), in which fish abundance fluctuations were found to be highly seasonal and largely related to reproductive activities. Strong planktivore recruitment at 9 and 18 m in March appeared to initiate the observed seasonal increase in overall fish abundance. This influx, as well as juvenile recruitment in general, might have been influenced by several factors promoting successful larval survival. Since spawning was not observed during this study, we have no data supporting the hypothesis that reef fish reproduction is seasonally intensified to coincide with factors favorable for larval survival and juvenile settlement. Similarly, this study did not examine the possibility that fish reproduction is relatively constant and that seasonality is the result of either differential larval survival throughout the year or fluctuations in the effects of predation and competition on newly settled recruits. However, because this investigation did yield data indicating that different trophic groups exhibited different patterns of seasonal abundance, it is possible that food availability may be an important "proximate" or "ultimate" cause influencing the observed seasonal peaks in overall fish abundance.

Kock (1982) proposed that seasonally abundant planktonic food may be important in timing the initiation of strong juvenile fish recruitment on Guam's upper reef slope. Accordingly, he inferred that the suspended particulate material resulting from seasonally desiccated reef-flat algae may somehow indirectly contribute to the nourishment of pelagic fish larvae, and

Table 6. Annual variation (AV) in ranked fish abundances of the 35 most ubiquitous fish species observed at Asan Pt. and Ipao Pt. Calculations are based on data collected during September, October and November, 1979 and 1980. $\bar{R}$ and AV are explained in text and in Wolfa (1978).

Study Site	Transect Depth (m)	September	October	November	$\bar{x}$
<u>$\bar{R}$:</u>					
Asan	A11	-0.08	0.06	0.04	0.01
Ipao	A11	-0.04	0.08	0.03	0.02
Both	5	0.03	0.01	-0.02	0.01
Both	9	-0.18	0.08	0.10	0.00
Both	18	0.02	0.09	0.09	0.07
Both	30	-0.02	-0.08	0.03	-0.02
<u>AV:</u>					
Asan	A11	0.09	0.06	0.17	0.11
Ipao	A11	0.10	0.10	0.07	0.09
Both	5	0.14	0.10	0.07	0.10
Both	9	0.14	0.14	0.10	0.13
Both	18	0.15	0.18	0.23	0.19
Both	30	0.04	0.15	0.12	0.10

Table 7. Annual variation in species composition of the 35 most ubiquitous fish species observed at Asan Pt. and Ipao Pt. as estimated by the Jaccard Coefficient (J). Calculations are based on data collected during September, October and November, 1979 and 1980. J is explained in text and in Sokal and Sneath (1963).

Study Site	Transect Depth (m)	September	October	November	$\bar{x}$
Asan	A11	0.97	0.91	0.94	0.94
Ipao	A11	0.97	0.97	0.91	0.95
Both	5 m	0.81	0.87	0.88	0.85
Both	9 m	0.82	0.85	0.85	0.84
Both	18 m	0.74	0.88	0.88	0.83
Both	30 m	0.82	0.66	0.72	0.73

Table 8. Annual variation in species composition of the 35 most ubiquitous fish species observed at Asan Pt. and Ipao Pt. as estimated by the Resemblance Index (R). Calculations are based on data collected during September, October and November, 1979 and 1980. R is explained in text and in Smith (1973).

Study Site	Transect Depth (m)	September	October	November	$\bar{x}$
Asan	A11	0.98	0.96	0.97	0.97
Ipao	A11	0.96	0.98	0.98	0.97
Both	5 m	0.90	0.93	0.93	0.92
Both	9 m	0.90	0.92	0.92	0.92
Both	18 m	0.85	0.93	0.94	0.91
Both	30 m	0.91	0.78	0.84	0.84

that the added benefit of this condition is ultimately manifested in the form of maximum juvenile settlement between March and June. Although the diurnal low-spring-tide season at Guam may begin around March, there is evidence that effective reef-flat algal desiccation may not occur until later in the season. Tsuda (1974) has shown that the algae which are most seasonal on Guam are intertidal species, the majority of which are most abundant between January and June. He also emphasized that the desiccation of intertidal algae is regulated by the critical factors of time of day and duration of exposure (Doty 1946; Lawson 1957) which are effectively met on Guam only during the months of May through August. Therefore, if seasonally abundant planktonic food is an important factor influencing successful springtime juvenile recruitment among upper reef-slope fishes, it is likely to result from a source that is of greater influence during the earlier part of the year. The results of the present study suggest a similar but contrasting explanation.

If, in general, the numbers in an animal population are at least partly regulated by food availability (Lack 1954; Pianka 1974), and since fish appear to spawn to gain most from the food available in the production cycle (Cushing 1975; Russell et al. 1977), the successful recruitment of *P. guamensis* presumably indicated the presence of abundant zooplankton. By the same logic, increases among the benthic invertebrate-feeders may indicate the presence of abundant benthic invertebrate prey, of which many species are also known to feed extensively on plankton. Indeed, Russell et al. (1977) pointed to the significance of a recruitment strategy in which fish abundance increases at a time when maximum food resources ensure conditions most favorable for growth. In addition, they mention evidence leading to the existence of subtle seasonal patterns in tropical primary production (Kinsey and Domm 1974), and the possible link between these patterns and the reproductive cycles in coral-reef fishes. In a northern hemispheric tropical ocean, phytoplankton production, largely controlled by solar radiation and wind, develops slowly through the fall and winter leading to maximum herbivorous zooplankton abundance around February (Cushing 1959, 1975), approximately the time of the initial planktivore influx observed during this study.

The much greater than average rain experienced in February (Fig. 2) may have added additional nutrients through rain-induced terrestrial run-off. The addition of detrital material after April due to the developing seasonal reef-flat algal kill may also be influential. Although peak abundances among the most ubiquitous carnivores did not show a significant relationship with the rainy season, it is reasonable to conclude from the observed trends that increased food availability in a variety of forms could have played an important role in their fluctuations. At the very least, the data clearly suggest that many of the planktivores, piscivores and benthic invertebrate-feeders within the fish community are capable of taking advantage of seasonal increases in their food supplies. Besides conferring potential growth benefits to recruiting juveniles, reproduction coincident with increasing levels of fluctuating food resources may allow adults to meet more successfully the energy demands spawning places upon them. Therefore, the relationship between food resource availability and fish abundance for spawners as well as recruits may have significance from both "proximate" physiological (Lagler et al. 1962) and "ultimate" evolutionary (Fisher 1930) perspectives.

Data on the herbivores led to the same general conclusion. Since these fishes have generally low assimilation efficiencies (Odum 1970; Chartok 1972), and retain food for only a few hours (Ogden and Lobel 1978), they also have relatively large food biomass requirements (Bardach 1961). In Guam, both adults and juveniles of several surgeonfish and parrotfish species commonly seen on the upper reef slope, are known to frequent the reef flat (Amesbury 1978; Amesbury and Myers 1982; Katnik 1982; Myers 1982), especially during high tides. When the relatively extensive reef-flat area that exists on Guam (Randall and Eldredge 1976) is considered, it is easy to imagine how beneficial the additional algal biomass associated with this zone might be to the shallow-water herbivorous fish community. However, in order to utilize even a limited amount of the energy stored in this biomass, many herbivorous fishes have had to adapt to a distinctive type of production cycle largely controlled by solar radiation, tide and rainfall.

As the diurnal low-spring-tide season develops, both grazers and browsers are excluded from foraging on the reef flat during certain hours of the day (Bakus 1967). Since most herbivorous fishes are nocturnally inactive (Hobson 1965, 1972; Starck and Davis 1966; Rosenblatt and Hobson 1969), this low-tide restriction of diurnal reef-flat foraging might be viewed as a condition less favorable to maximum growth, especially among juvenile browsers. Widespread reduction in food resources due to desiccation (Tsuda 1974) during the fully developed diurnal low-spring-tide season also may be highly stressful to foraging herbivore populations, and in particular to those browsers most intimately associated with the reef flat. The severity of this form of environmental stress is compounded by seasonally high rainfall (Fig. 2) which serves to extend the time period of algal reduction by preventing the reef-flat community from starting to reestablish itself as soon as the critical midday low-tide season ends. Rainfall continuing into the later months of the year could produce reef-flat salinities low enough to delay the reappearance of upper intertidal algae until January (Tsuda 1974). The increase in fish abundance that occurred most notably in shallower water during the fall may have been related to reproduction among grazers in response to lengthening diurnal foraging time on the reef flat, and among browsing surgeonfishes in response to the reestablishment of the reef-flat algal community.

Because of the rather ubiquitous nature of their food source and their wide-ranging foraging habits, parrotfishes may be less dependent than browsing surgeonfishes upon the reef flat, and thus, may also be relatively less affected by the seasonal diurnal restriction of reef-flat foraging. This may be supported by the comparatively lower juvenile representation of the latter species observed on the upper reef slope during this study, which also suggests that reproduction among browsing surgeonfishes may be more responsive to changes in reef-flat algal biomass. The herbivores that peaked in abundance earlier in the year were mostly territorial damselfishes that commonly inhabit the reef front and submarine terrace. Others included deeper-water angelfishes, parrotfishes and surgeonfishes. The effects of seasonally reduced reef-flat algal biomass might be felt indirectly by these damselfishes and angelfishes in the form of temporarily increased interspecific competition for food (Barlow 1974), particularly since subtidal algae appear to flourish year round (Tsuda 1974).

Certain nonherbivorous fishes may also take advantage of reproducing during the fall for a similar reason, since increasing plankton, algal production and detritus accumulations on the reef flat may support a significant biomass of benthic invertebrates as well. However, reproduction during the fall may be of secondary importance to these species since they are not as directly dependent as herbivores on reef-flat algal biomass. Thus, nonherbivorous species may spread their reproductive activities over a longer period of time which may partially explain why peak abundances within the most ubiquitous carnivore group analyzed in this study did not prove to be significantly correlated with the April to June period.

Despite numerical variations in seasonal abundance, the fish community in general seems to exhibit a fairly predictable annual cycle returning to similar levels after a 12-month period. The resulting low values of AV (Table 6) characterize the fish community on the upper reef slope as being relatively persistent. The values of AV calculated for upper reef-slope fishes on Guam may be compared with those calculated for organisms in less climatically stable regions (Table 9). The values for Guam are slightly lower but similar to those for marine fishes in southern California (Ebeling et al. 1980), and they are lower than those for marine fishes in northern California (Miller and Geibel 1973; Burge and Schultz 1973) and for estuarine fishes in northern Florida (Livingston 1976).

The high annual constancy in species composition found during this study also indicates the presence of a fairly persistent fish community on the scale analyzed (Tables 7 and 8). These results generally agree with other studies of fish assemblages made on relatively large areas of coral reef (Smith and Tyler 1972, 1975; Smith 1973; Gladfelter et al. 1980; Kock 1982), but are in contrast to the results of studies of very small natural fish assemblages (Sale 1977; Sale and Dybdahl 1975, 1978) and assemblages on comparatively small natural reefs (Nolan 1975; Sale 1980) and artificial reefs (Russell et al. 1974, 1977; Talbot et al. 1978). Differences in either the spatial scale used or the time interval between compared censuses could greatly affect the outcome of such comparisons (Diamond and May 1977; Talbot et al. 1978; Sale 1983). In this regard, less variation is predicted for data collected on larger spatial scales and after long inter-census periods. Less variability may also result from comparisons of between-year censuses for a single month than from comparisons of monthly censuses made within a single year. The particular time of year analyzed may also affect the outcome of such annual comparisons.

The trend in observed overall species richness across depth (Tables 1 and 2) raises an interesting point concerning the diversity of coral-reef fishes. The lower species richness found at 30 m in the present study would be expected since greater environmental stability (or conditions of relatively less frequent and less intense natural disturbances) would allow the forces of competition and predation among species to act relatively more continuously over longer periods of time. A result of this would be the elimination of less fit members from the community at a comparatively faster rate. Stability should decrease with decreasing depth as natural disturbances primarily in the form of predation (Talbot et al. 1978) are expected to more frequently or more intensely interrupt the competitive process by nonselectively removing a greater proportion of the more fit

Table 9. Comparison of annual variation (AV) in ranked species abundances calculated for some organisms living in different geographical areas and climatic regimes. AV values measure the scope of yearly changes in species abundances, where relatively low values indicate generally little change. (See text and Wolda 1978).

AV	ORGANISM	LOCATION	REFERENCE
0.55*	Estuarine Fishes	North Florida	Livingston 1976
0.34	Arthropods	Dry, unstable climate	Wolda 1978
0.20*	Marine Fishes	Diablo Cove, Calif.	Burge & Schultz 1973
0.17*	Marine Fishes	Monterey Bay, Calif.	Miller & Geibel 1973
0.15	Arthropods	Humid, stable climate	Wolda 1978
0.15	Marine Fishes	Santa Cruz Is., Calif.	Ebeling <u>et al.</u> 1980
0.11	Marine Fishes	Naples Reef, Calif.	Ebeling <u>et al.</u> 1980
0.11	Marine Fishes	Ipao Pt., Guam	This study
0.09	Marine Fishes	Asan Pt., Guam	This study

* = Values calculated by Ebeling et al. (1980)

members from the community, thereby enabling a greater number of species to coexist. This would occur to a depth above which the disturbances may become so frequent or intense that species diversity becomes limited by severe environmental conditions. In this form of the "intermediate disturbance hypothesis" (Connell 1978), it may be that the frequency and intensity of natural disturbances at the surface due to storms, large waves, surface currents etc. are replaced by the effects of increased predation on the submarine terrace down to a point somewhere near a depth of 18 m. While both of these sources of localized small-scale disturbance would be expected to influence species richness, predation is likely to be the most important (Talbot et al. 1978). For the sake of comparison, data from two other depth-related studies were drawn from the literature (Gosline 1965; Harmelin-Vivien 1977). In these studies, numbers of species were given for several depth ranges. In order to graph all the data together, the number of species per depth range was assigned to the mean depth of each reported range. The results (Fig. 10) proved to be remarkably consistent.

CONCLUSIONS

The coral-reef fishes on the upper reef slope at Guam exhibit seasonal variations that appear to result largely from reproductive activities which may be closely related to food resource availability. Seasonal fluctuations between carnivore and herbivore groups overlap but show depth-related temporal differences in peak abundance that may be the result of adaptations to different food resources. Climatological and oceanographic phenomena seem to play indirect, but important roles in the timing of seasonal fish abundance by their apparent influences on primary production cycles and reproductive success in fishes. The upper reef-slope fish community in general exhibits a persistent structure that has evidently evolved in response to a predictable environment of relative climatic stability. The applicability of the "intermediate disturbance hypothesis" to mobile animals is demonstrated by fishes across depth on the upper reef slope.

RECOMMENDATIONS

Job 5 should be terminated with this report. The results of this study suggest several possible avenues of future investigation into the reproductive and trophic relationships among coral-reef fishes. Data presented here on several recreationally important species should be compared with DAWR creel census data in order to identify possible seasonal trends in the fisheries for these species. The information presented may be useful to fisheries biologists in managing inshore reef fisheries on both the relatively healthy and heavily impacted reefs of Guam.

Report prepared by: Michael E. Molina

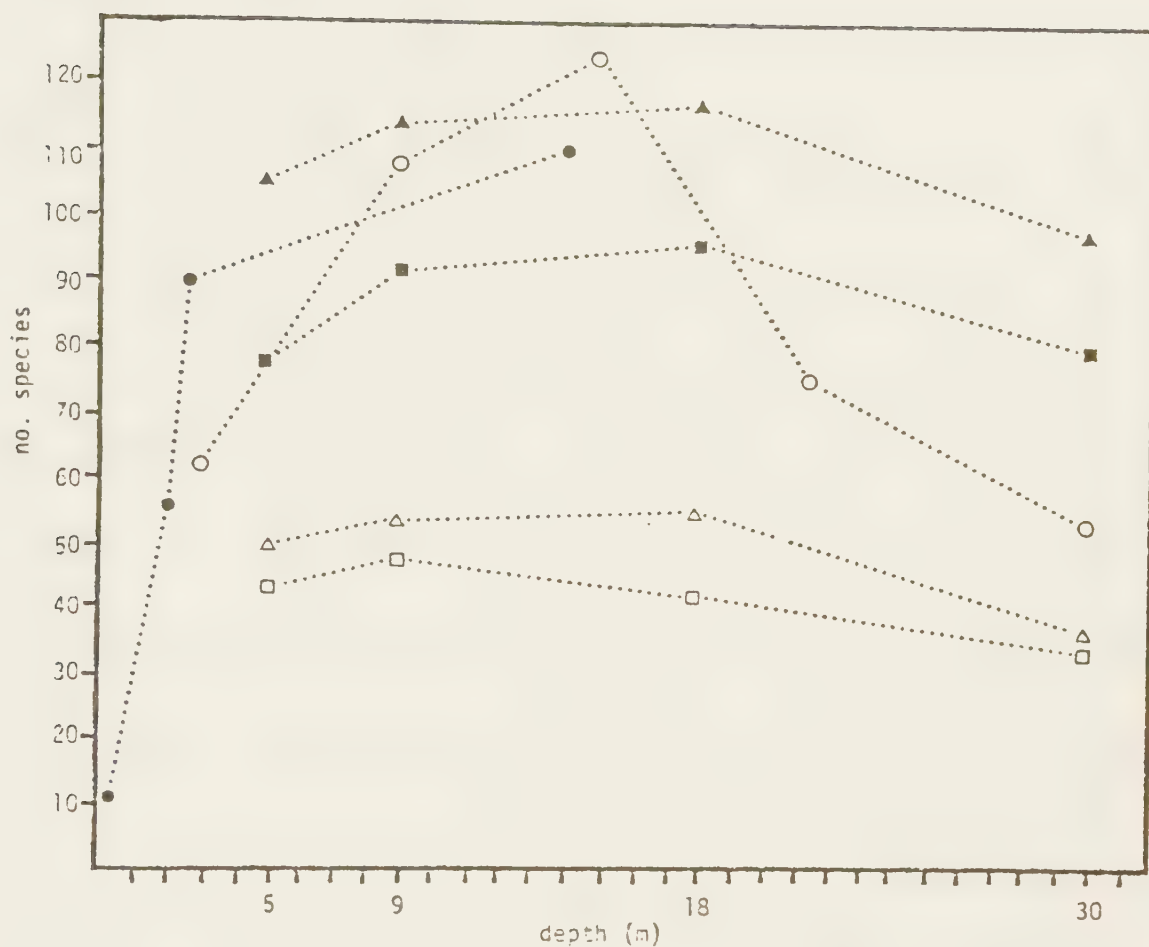


Figure 8. Actual and mean species richness (number of species) observed at Asan Pt. and Ipao Pt. study sites by depth. ■ = Asan Pt. (total no. species); ▲ = Ipao Pt. (total no. species); □ = Asan Pt. ($\bar{x}$ no. species/month); △ = Ipao Pt. ($\bar{x}$ no. species/month); ● = Oahu, Hawaii (total no. species, Gosline 1965); ○ = Tulear Reef, Madagascar (total no. species, Harmelin-Vivien 1977).

REFERENCES CITED

- Allen, G. R. 1975. Damselfishes of the south seas. T. F. H. Publications, Inc., Neptune City, N. J. 240 p.
- Amesbury, S. A. 1978. Studies on the biology of the reef fishes of Guam. Part I: Distribution of fishes on the reef flats of Guam. Part II: Distribution of eggs and larvae of fishes at selected sites on Guam. Univ. Guam Mar. Lab., Tech. Rept. 49. 65p.
- Amesbury, S. A. and R. F. Myers. 1982. Guide to the coastal resources of Guam. Volume I: The fishes. Univ. Guam Press. 141p.
- Andrewartha, H. G. and L. C. Birch. 1954. The distribution and abundance of animals. Univ. Chicago Press, Chicago, Il. 782p.
- Bakus, G. J. 1967. The feeding habits of fishes and primary production at Eniwetok, Marshall Islands. *Micronesica* 3:135-149.
- Bardach, J. E. 1961. Transport of calcareous fragments by reef fishes. *Science* 133(3446):98-99.
- Barlow, G. W. 1974. Extraspecific imposition of social grouping among surgeonfishes (Pisces: Acanthuridae). *J. Zool. Lond.* 174:333-340.
- Benedek, P. 1970. The Hungarian countrywide light-trap network in the service of plant protecting forecasting. Europe. Mediterranean Plant Protection Organ. Pub. A. 57:163-167.
- Burge, R. T. and S. A. Schultz. 1973. The marine environment in the vicinity of Diablo Cove with special reference to abalones and bony fishes. Calif. Dep. Fish Game Mar. Resour., Tech. Rep. 19. 433p.
- Chartock, M. A. 1972. The role of detritus in a tropical marine ecosystem: niche separation in congeneric ophiuroids, food partitioning in cryptic invertebrates, and herbivore detritus production at Eniwetok, Marshall Islands. Ph.D. Thesis, Univ. S. Calif. 177p.
- Connell, J. H. 1978. Diversity in tropical rain forests and coral reefs. *Science* 199:1302-1310.
- Cushing, D. H. 1959. On the nature of production in the sea. *Fish. Invest. Lond. Ser. 2.* 21(5):27p.
- _____. 1975. Marine ecology and fisheries. Cambridge Univ. Press., London, Great Britain. xiv + 278p.
- Diamond, J. M. and R. M. May. 1977. Species turnover rates on islands: dependence on census interval. *Science* 197:266-270.
- Doty, M. S. 1946. Critical tide factors that are correlated with vertical distribution of marine algae and other organisms along the Pacific coast. *Ecology* 27(4):315-327.

- Ebeling, A. W., R. J. Larson, W. S. Alevizon and R. N. Bray. 1980. Annual variability of reef fish assemblages in kelp forests off Santa Barbara, California. *Fish. Bull.* 78(2):361-377.
- Fisher, R. A. 1930. The genetical theory of natural selection. Clarendon Press. Oxford. 272p.
- Gladfelter, W. B. J., J. C. Ogden and E. H. Gladfelter. 1980. Similarity and diversity among coral reef fish communities, a comparison between Tropical Western Atlantic (Virgin Islands) and Tropical Central Pacific (Marshall Islands) patch reefs. *Ecology* 61:1156-1168.
- Gosline, W. A. 1965. Vertical zonation of inshore fishes in the upper water layers of the Hawaiian Islands. *Ecology* 46(1):823-831.
- Harmelin-Vivien, M. L. 1977. Ecological distribution of fishes on the outer slope of Tulear Reef (Madagascar). *Proc. 3rd Intern. Coral Reef Symp.* 1:289-295.
- Hobson, E. S. 1965. Diurnal-nocturnal activity of some inshore fishes in the Gulf of California. *Copeia* 1965:291-302.
- _____. 1972. Activity of Hawaiian reef fishes during the evening and morning transitions between daylight and darkness. *Fish. Bull.*, 70:715-740.
- _____. 1974. Feeding relationships of teleostean fishes on coral reefs in Kona, Hawaii. *Fish. Bull.* 72:915-1031.
- Johannes, R. E. 1978. Reproductive strategies of coastal marine fishes in the tropics. *Env. Biol. Fish.* 3(1):65-84.
- Jones, R. S. 1968. Ecological relationships in Hawaiian and Johnston Island Acanthuridae (surgeonfishes). *Micronesica* 4:309-361.
- Katnik, S. E. 1982. Effects of fishing pressure on the reef flat fisheries of Guam. M. S. Thesis. Univ. of Guam. 62p.
- Kinsey, D. W. and A. Domm. 1974. Effects of fertilization on a coral reef environment - primary production studies. In: A. M. Cameron et al. (eds.), *Proc. 2nd Intern. Coral Reef Symp.* 1:49-66.
- Kock, R. L. 1982. Patterns of abundance variation in reef fishes near an artificial reef at Guam. *Env. Biol. Fish.* 7(2):121-136.
- Lack, D. 1954. The natural regulation of animal numbers. Oxford Univ. Press, London. 343p.
- Lagler, K. F., J. E. Bardach and R. R. Miller. 1962. *Ichthyology*. John Wiley and Sons, Inc., New York. xiii + 545 p.
- Lawson, G. W. 1957. Seasonal variation of intertidal zonation on the coast of Ghana in relation to tidal factors. *J. Ecol.* 45:831-860.

- Livingston, R. J. 1976. Diurnal and seasonal fluctuations of organisms in a north Florida estuary. *Estuarine Coastal Mar. Sci.* 4:373-400.
- Luckhurst, B. E. and K. Luckhurst. 1977. Recruitment patterns of coral reef fishes on the fringing reef of Curacao, Netherlands Antilles. *Can. J. Zool.* 55:681-689.
- Miller, D. J. and J. J. Geibel. 1973. Summary of blue rockfish and lingcod life histories, a reef ecology study; and giant kelp, Macrocystis pyrifera, experiments in Monterey Bay, California. *Calif. Dep. Fish Gam, Fish. Bull.* 158. 137p.
- Myers, R. F. 1982. Fishes. In: R. H. Randall and L. G. Eldredge (eds.), *Assessment of the shoalwater environments in the vicinity of the proposed OTEC development at Cabras Island, Guam*. Univ. Guam Mar. Lab., Tech. Rept. 79:132-173.
- National Oceanic and Atmospheric Administration. 1979. Climatological Data: Annual Summary (Hawaii and Pacific). Nat. Climate Cent., Fed. Bldg., Asheville, N. C. 21p.
- _____. 1980. Climatological Data: Annual Summary (Hawaii and Pacific). Nat. Climate Cent., Fed. Bldg., Asheville, N. C. 26p.
- Nolan, R. S. 1975. The ecology of patch reef fishes. Ph.D. thesis, University of California, San Diego. 230p.
- Odum, W. E. 1970. Utilization of the direct grazing and plant detritus food chains by the stripped mullet Mugil cephalus. In: J. H. Steele (ed.), *Marine Food Chains*. Otto Koeltz Sci. Publ., Koenigstein: 222-240.
- Ogden, J. C. and P. L. Lobel. 1978. The role of herbivorous fishes and urchins in coral reef communities. *Env. Biol. Fish.* 3:49-63.
- Peterson, R. D. 1972. Effects of light intensity on the morphology and productivity of Caulerpa racemosa. *Micronesica* 8:63-86.
- Pianka, E. R. 1974. *Evolutionary ecology*. Harper and Row, New York. 356p.
- Randall, J. E. and W. Klausewitz. 1973. A review of the triggerfish genus Melichthys, with a description of a new species from the Indian Ocean. *Senckenbergiana biol.* 54(1/3):57-69.
- Randall, R. H. and L. G. Eldredge. 1976. *Atlas of the reefs and beaches of Guam*. Coastal Zone Management Section, Bureau of Planning, Agana, Guam. 191p.
- Randall, R. H. and J. Holloman. 1974. *Coastal survey of Guam*. Univ. Guam Mar. Lab., Tech. Rept. 14. 404p.
- Rosenblatt, R. H. and E. H. Hobson. 1969. Parrotfishes (Scaridae) of the

eastern Pacific, with a generic rearrangement of the Scarinae. *Copeia* 1969: 434-453.

- Russell, B. C., G. R. V. Anderson and F. H. Talbot. 1977. Seasonality and recruitment of coral-reef fishes. *Aust. J. Mar. Freshw. Res.*, 28:521-528.
- Russell, B. C., F. H. Talbot and S. Domm. 1974. Patterns of colonization of artificial reefs by coral-reef fishes. In: A. M. Cameron et al. (eds.), *Proc. 2nd Intern. Coral Reef Symp.* 1:207-215.
- Sale, P. F. 1977. Maintenance of high diversity in coral-reef fish communities. *Am. Nat.* 111:337-359.
- _____. 1980. Assemblages of fish on patch reefs - predictable or unpredictable? *Env. Biol. Fish.* 5(3):243-249.
- _____. 1982. The structure and dynamics of coral reef fish communities. In Pauly, D. and G.I. Murphy (eds.) *Theory and management of tropical fisheries. ICLARM Conference Proceedings* 9:241-254.
- Sale, P. F. and R. Dybdahl. 1975. Determinants of community structure for coral-reef fishes in an experimental habitat. *Ecology* 56:1343-1355.
- _____. 1978. Determinants of community structure for coral-reef fishes in isolated coral heads at lagoonal and reef slope site. *Oecologia* 34:57-74.
- Shepard, J. W. and R. F. Myers. 1981. A preliminary checklist of the fishes of Guam and the southern Mariana Islands. In: *A working list of marine organisms from Guam. Univ. Guam Mar. Lab., Tech. Rept.* 70:60-88.
- Smith, C. L. 1973. Small rotenone stations: a tool for studying coral reef fish communities. *Am. Mus. Novitates* 2512:1-21.
- Smith, C. L. and J. C. Tyler. 1972. Space resource sharing in a coral reef fish community. In: B. B. Collette and S. A. Earle, (ed.) *Results of the Tektite Program: ecology of coral reef fishes. Los Angeles Co. Mus. Sci. Bull.* 14:125-170.
- _____. 1975. Succession and stability in fish communities of dome-shaped patch reefs in the West Indies. *Am. Mus. Novitates* 2572:1-18.
- Sokal, R. R. and P. H. Sneath. 1963. *Principles of numerical taxonomy.* W. H. Freeman and Co., San Francisco 359 p.
- Starck, W. A., II, and W. P. Davis. 1966. Night habits of fishes of Alligator Reef, Florida. *Ichthyol. Aquarium J.* 38:313-356.
- Talbot, F. H., B. C. Russell and G. R. V. Anderson. 1978. Coral-reef fish communities: unstable, high-diversity systems? *Ecol. Monogr.* 48:425-440.

- Tsuda, R. T. 1974. Seasonal aspects of the Guam Phaeophyta (brown algae). In: A. M. Cameron et al. (eds.), Proc. 2nd. Intern. Coral Reef Symp. 1:43-47.
- Watson, W. and J. J. Leis. 1974. Ichthyo-plankton in Kaneohe Bay, Hawaii. A one-year study of fish eggs and larvae. Univ. Hawaii Sea Grant Tech. Rept. 75-01:1-178.
- Williams, D. McB. and P. F. Sale. 1981. Spatial and temporal patterns of recruitment of juvenile coral reef fishes to coral habitats within "One Tree Lagoon", Great Barrier Reef. Mar. Biol. 65:245-253.
- Wolda, H. 1978. Fluctuations in abundance of tropical insects. Am. Nat. 112:1017-1045.

JOB PROGRESS REPORT
RESEARCH PROGRESS SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-19
SUB-PROJECT NO.: F
STUDY NO.: F-I
JOB NO.: 8

JOB TITLE: Studies of Recreationally Important Reef Fish

PERIOD COVERED: October 1, 1981 to September 30, 1982

SUMMARY

Beginning in January 1982, populations of recreationally important reef fish species were monitored monthly at three sites on Luminao Barrier Reef. The most striking feature of the fish populations at these sites is their temporal variability, throughout all size classes (excluding recruits). At all three sites, large individuals (> 25 cm FL) were greatly outnumbered by smaller-sized individuals. Although variability makes interpretation of the results difficult, numbers of large size-class individuals appeared to increase during the study at one of the sites.

A literature search for information on Siganus spinus, Mulloidides flavolineatus, Caranx melampygus and Selar crumenophthalmus was conducted at the Hamilton Library, University of Hawaii at Manoa. Within the last 10 years less than 20 citations dealing specifically with these species have been listed in Aquatic Sciences and Fisheries Abstracts (ASFA) and Biological Abstracts (BIOSIS). Growth data on these species were compiled in the field on Guam from fishermen's catches. Past creel census data were reviewed for information on catch rates by location, seasonality and length/weight relationships. Due to limited personnel and conflicts in job priorities, work on this part of Job-8 was curtailed during the latter part of FY 82, but will be continued as soon as possible. As a result, this report will summarize progress made primarily in the monitoring of populations of recreationally important fish species on Luminao Barrier Reef. Data collected on selected species of reef fish will be presented in our next annual report or whenever problems with personnel limitations and job priorities are alleviated so that a proper analysis may be accomplished.

BACKGROUND

In addition to reliable data on fishing participation, effort and catch, proper management of a fishery requires pertinent biological knowledge of the species involved. Such information may be used as a basis for sound management decisions in maintaining or improving the quality of sport fishing on Guam while providing requisite data to support government policy and laws related to fish and fishing.

On October 24, 1981, Public Law 16-39 went into effect, closing the Luminao Barrier Reef along the north (ocean) side of Apra Harbor's Glass Breakwater to all forms of net fishing. At this time the Division of Aquatic and

Wildlife Resources (DAWR) assumed the responsibility of monitoring populations of recreationally important reef fishes at that location. On December 3, 1982, Public Law 16-114 went into effect, closing the Luminao Barrier Reef to all fishing or taking of any marine life, by any means, for a trial period to end no sooner than October 1, 1983.

During the latter part of 1980, a study of the fish communities of the Luminao-Piti reef complex was conducted (Myers, 1982). The sampling method (primarily the use of 50m transects) was designed to roughly enumerate the populations of all resident reef fish species. This study did not concentrate specifically on the more recreationally important species, such as the larger resident and transient species and seasonal juveniles. Many of these occurred in low numbers, or seasonally and may have been overlooked. For these reasons, and in response to the closure of Luminao Barrier Reef to the taking of marine life, an independent study, utilizing a different methodology was initiated by DAWR.

A second part of this study involves obtaining more specific information on the biology and life history of selected reef fish species. Among the more recreationally important inshore species traditionally targeted by fishermen on Guam are Siganus spinus (Siganidae), Mulloides flavolineatus (Mullidae), Caranx melampygus and Selar crumenophthalmus (Carangidae). Since these species are highly desired both as juveniles and adults their stocks must sustain considerable levels of fishing pressure. As the island of Guam develops, and as fishing continues to be an increasingly important recreational activity for residents and tourists alike, these and other species must be conserved and protected from overexploitation and misuse.

OBJECTIVES

- I. To monitor population trends of recreationally important reef fishes on Luminao Barrier Reef, shoreward of the reef margin.
- II. To assess the impact of fishing on populations of recreationally important reef fishes on Luminao Barrier Reef.
- III. To obtain sufficient information on the biology and life history of selected recreationally important reef fish species (such as Siganus spinus, Selar crumenophthalmus, Caranx melampygus and Mulloides flavolineatus) in order to permit evaluation of the need for fishing regulations and population management.

PROCEDURES

1. Three sites, each representing somewhat different major habitats, were selected (Figure 1). The first is situated on the eastern end of the reef, approximately 10 meters from the Glass Breakwater and opposite the ammunition wharf. The two remaining sites are situated near the western end, and widest point, of the reef. One is located within 20 m of the Glass Breakwater, the other in an area of rich coral growth within 70 m of the reef margin. At each site, two stakes were driven into the substrate to designate endpoints of permanent 100 m transects running parallel to the Glass Breakwater. Beginning in January, 1982, a series of monthly counts were conducted along each transect. All fishes that were considered important, and observed within 3 m of an imaginary transect



Figure 1. Map of the Luminao-Piti reef system showing locations of fish transects.

line, were tallied. Nocturnal species which often occur in holes and under ledges by day were not considered, nor were a few species incidentally utilized by fishermen. All species were separated into size intervals of 7 to 12.5 cm, 12.5 to 25 cm, and > 25 cm FL, respectively. Newly recruited juveniles of certain species were also tallied. All monthly counts were taken within a 1 to 2 day period. In an effort to minimize variability due to temporal and tidal factors, all counts were conducted between the hours of 1300 and 1700, and during tidal levels of approximately 1.5 ft. above mean low water. A brief summary of the results of twelve months of counts during calendar year 1982 is presented below and shown graphically in Figures 2-4.

2. Review scientific literature pertaining to selected reef fish.
3. Conduct species specific analyses of past Division of Aquatic and Wildlife Resources' creel census data, identifying trends in catch abundance by location; seasonality; and length/weight relationships.
4. Conduct reef studies using visual surveys and specimen collections to obtain estimates on various parameters including standing crop, population, reproductive potential, survivorship, seasonality and feeding and habitat requirements.
5. Analyse and interpret accumulated data on an annual basis.

RESULTS

The most obvious, general characteristic of the fish populations at Luminao Barrier Reef was their variability in the transect counts. This holds true for all size classes (except seasonal recruits) and sites, making it difficult to detect and interpret trends. A number of factors may have contributed to this variability, including: (1) the transient nature of many species within the transect area, (2) variability between counts due to difficulty at some sites in swimming a straightline, (3) omissions and duplications in the counts due to the rapid and simultaneous movement of many different individuals and species, (4) inaccuracy in visually separating size classes within and between counts, and (5) variability in sheltering behavior both within and between species. It is widely known that sampling by means of visual transect provides only a crude estimate of fish populations. It is, however, the best non-destructive method available, and the only practical one in the present situation. Despite its flaws, this method should eventually allow detection of long-term trends.

It should be noted that only potentially exploitable, diurnally active, food-fishes are represented in Figure 2. These include parrotfishes, most species of surgeonfishes, a few of the larger wrasses, snappers, emperors, groupers, scorpionfishes, rabbitfishes and sharks (Table 1). Juvenile (Ee) and adult Bluefin Trevally (Carangidae: Caranx melampygus) were not encountered on the transects, but were observed in the area. At all three sites, large fishes (> 25 cm FL) were greatly outnumbered by smaller size-class fishes, of both the same, and different species. Approximately equal numbers of small and medium size-class individuals were surveyed throughout most of the study period, although these numbers fluctuated widely. At site 2 there appeared to be a general increase in the number of large size-class individuals. This observation may indicate that net fishing has been instrumental in removing

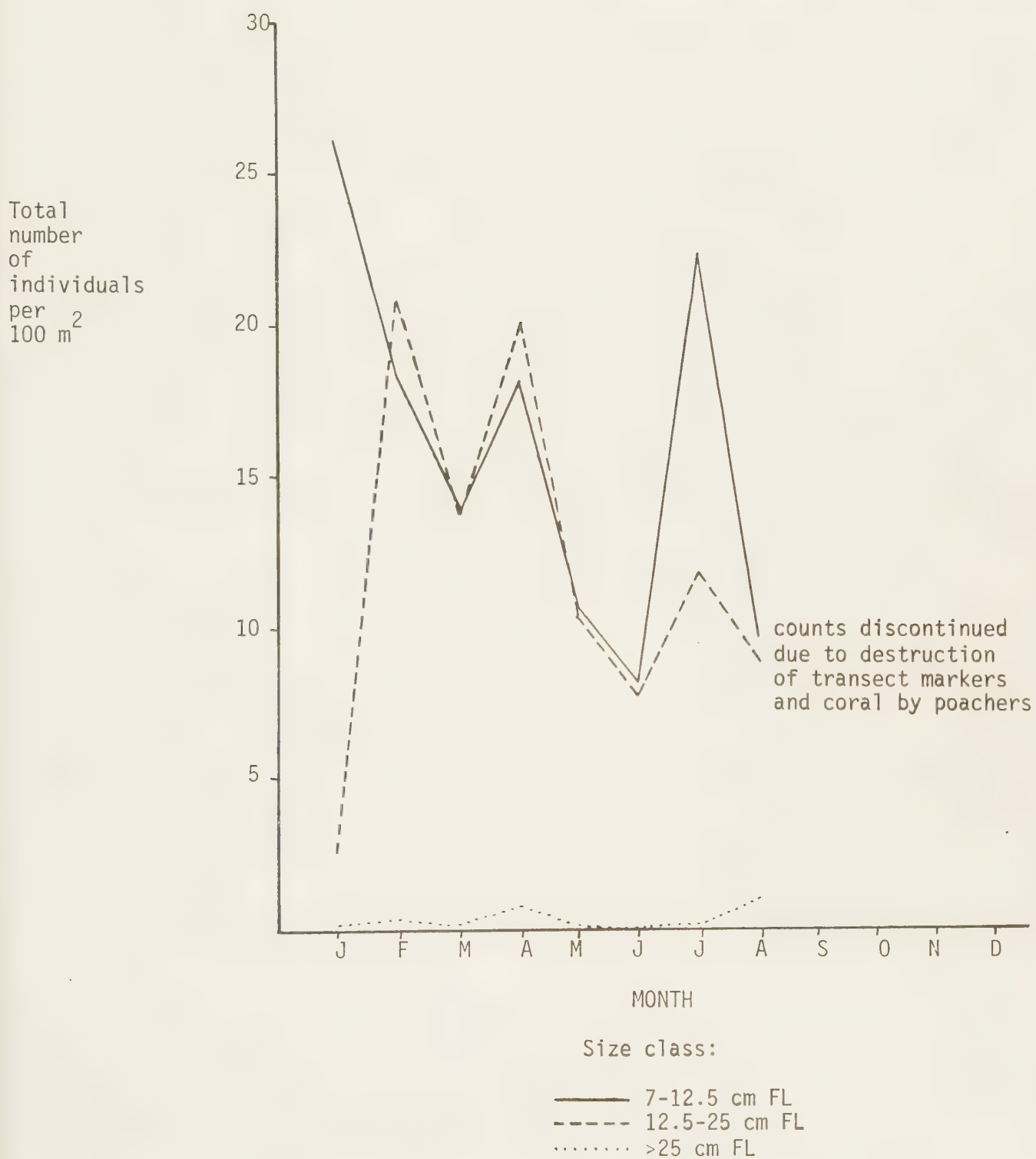


Figure 2. Density of recreationally valuable fishes at site 1 during 1982.

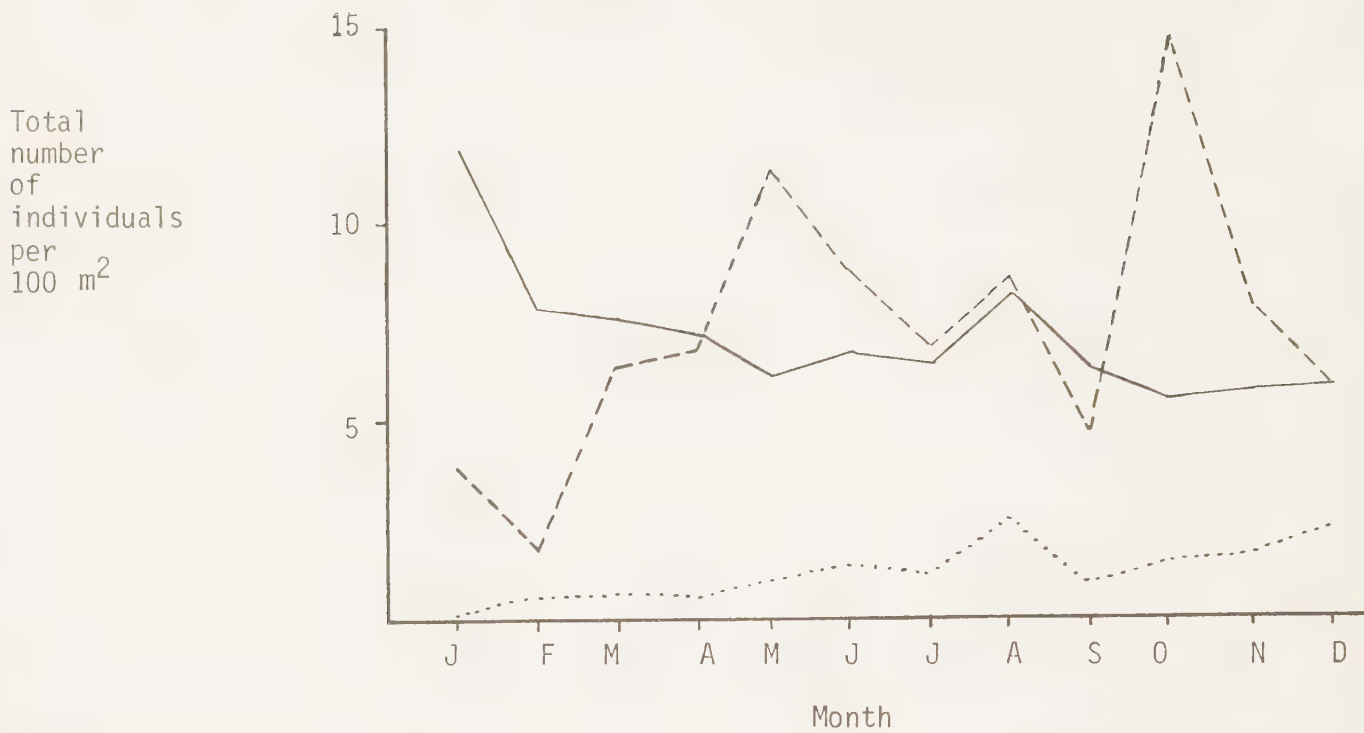


Figure 3. Density of recreationally valuable fishes at site 2 during 1982.

See Fig. 2 for key.

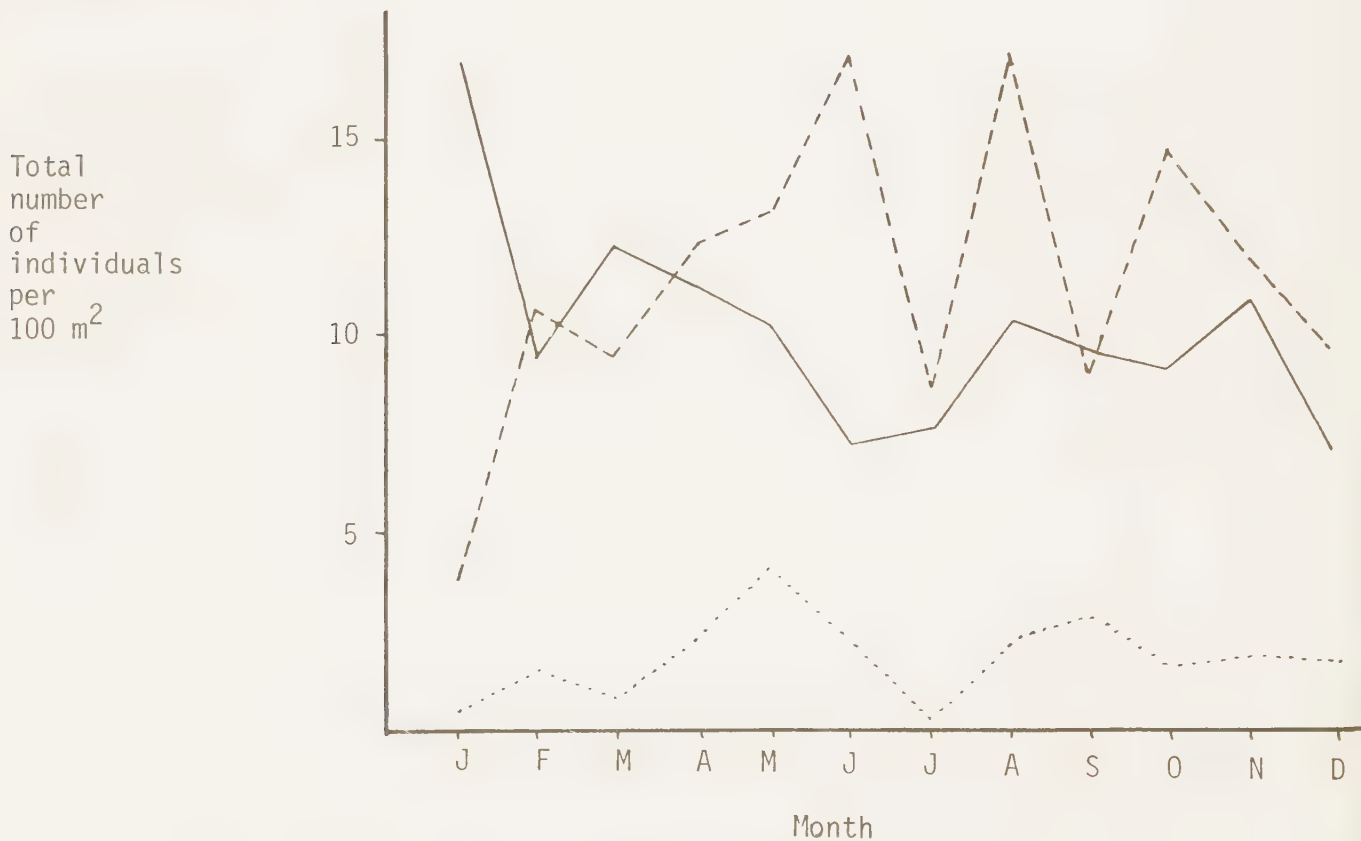


Figure 4. Density of recreationally valuable fishes at site 3 during 1982.

See Fig. 2 for key.

Table 1. List of Recreationally Important Fish Species Monitored on Luminao Barrier Reef.

Species

Carcharhinidae (Sharks)	<u>Halichoeres hortulanus</u>
+ <u>Carcharhinus melanopterus</u>	<u>H. marginatus</u>
Muraenidae (Moray Eels)	<u>Hemigymnus fasciatus</u>
<u>Echidna nebulosa</u>	<u>H. melapterus</u>
+Scorpaenidae (Scorpionfishes)	<u>Macropharyngodon meleagris</u>
<u>Scorpaenopsis diabolus</u>	<u>Novaculichthys taeniourus</u>
Serranidae (Groupers)	<u>Thalassoma hardwickei</u>
<u>Epinephelus merra</u>	<u>T. purpureum</u>
Lutjanidae (Emperors)	Scaridae (Parrotfishes)
<u>Lutjanus fulvus</u>	<u>Calotomus</u> sp.
Nemipteridae (Monocle Breams)	<u>Scarus brevifilis</u>
<u>Scolopsis cancellatus</u>	<u>S. frontalis</u>
Gerreidae (Mojaras)	+ <u>S. oviceps</u>
<u>Gerres</u> sp.	<u>S. psittacus</u>
Lethrinidae (Emperors)	+ <u>S. schlegeli</u>
<u>Gnathodentex aureolineatus</u>	<u>S. sordidus</u>
<u>Lethrinus harak</u>	+ <u>S. rubroviolaceus</u>
<u>L. xanthocheilus</u>	Acanthuridae (Surgeonfishes)
+ <u>Monotaxis grandoculus</u>	<u>Acanthurus glaucopareius</u>
Mullidae (Goatfishes)	<u>A. lineatus</u>
<u>Mulloides flavolineatus</u>	<u>A. mata</u>
<u>M. vanicolensis</u>	+ <u>A. nigricaudus</u>
<u>Parupeneus barberinus</u>	<u>A. nigrofuscus</u>
<u>P. bifasciatus</u>	<u>A. nigroris</u>
<u>P. cyclostomus</u>	<u>A. triostegus</u>
<u>P. pleurostigma</u>	<u>Ctenochaetus striatus</u>
<u>P. trifasciatus</u>	+ <u>Naso annulatus</u>
Pomacentridae (Damsel fishes)	<u>N. lituratus</u>
<u>Abudefduf septemfasciatus</u>	<u>N. unicornis</u>
Labridae (Wrasses)	<u>N. vlamingi</u>
<u>Anampses caeruleopunctatus</u>	<u>Zebrasoma veliferum</u>
<u>Cheilinus chlorurus</u>	Signaidae (Rabbitfishes)
<u>C. trilobatus</u>	<u>Siganus spinus</u>
<u>Cheilio inermis</u>	Monocanthidae (Filefishes)
<u>Coris aygula</u>	<u>Cantherhines dumerili</u>
<u>C. gaimardi</u>	Balistidae (Triggerfishes)
<u>Epibulus insidiator</u>	<u>Rhinecanthus aculeatus</u>
	<u>R. rectangularis</u>

*Only those individuals over 7 cm FL are considered. Species not listed that may reach 12.5 mm FL were not considered. Holocentrids were not monitored due to their propensity to stay hidden during daylight hours. Elongate species (Belonidae, Hemiramphidae, Aulostomidae, Fistulariidae) were not considered. Juvenile mullids, scarids and acanthurids under 7 mm are currently being monitored, but are not treated in this preliminary report.

+Not listed in Myers (1982).

large-sized individuals from fish populations in the past. The absence of a clear trend in the data supporting this may be partially due to the ineffectiveness of the law. A general lack of public awareness and the difficulty in maintaining strict law enforcement resulted in a certain level of net fishing being conducted throughout the study period. This probably dampened the effect that a true absence of net fishing would have had. Unfortunately, the long-term effect of net fishing alone cannot be assessed since the study site was recently closed to all forms of fishing for the remainder of FY 83. This, however, should ultimately result in a more noticable shift toward greater numbers of large and medium-sized individuals as long as the ban on fishing is effective and enough time is provided.

RECOMMENDATIONS

This study should be continued to permit evaluation of the long-term effects of reduced fishing pressure on Luminao Barrier Reef. Studies of the biology and life history of selected species of reef fish should continue in order to provide a sound basis for proper management decisions.

REFERENCES

- Myers, R.F. 1982. Fishes. In Assessment of the shoalwater environments in the vicinity of the proposed OTEC development at Cabras Island, Guam. R.H. Randall and L.G. Eldredge, eds. Univ. of Guam Marine Lab. Tech. Rep. No. 79, ii, 208 pp.

Report prepared by Robert F. Myers and Michael E. Molina

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-19

SUB-PROJECT NO.: F

STUDY NO.: F-1

JOB NO.: 9

JOB TITLE: Pelagic Fish Feeding Study

PERIOD COVERED: October 1, 1981 to September 30, 1983

SUMMARY

Between December 10, 1981 and January 1, 1982, 1398 stomachs from 16 species of pelagic game fishes were collected at Guam or Rota. One hundred and four stomachs were obtained during the Mariana Fishing Derby and 62 were obtained during the Rota Fishing Derby. The remainder were obtained at the Guam Fishermen's Cooperative throughout all months of the study period. To date, 628 (45%) stomachs have been examined and their contents recorded or preserved for subsequent identification. A preliminary examination of the data shows that of the five species for which 10 or more stomachs have been examined, fish remains occurred more frequently than any other kind of prey. Mahimahi (Coryphaena hippurus) fed most frequently on flying fishes, while other species fed heavily on larval or post larval inshore fishes. Crustaceans and cephalopods were more frequently eaten by yellowfin tuna (Thunnus albacares) than by any of the other species.

BACKGROUND

Numerous studies have indicated that tunas (Scombridae), mahimahi (Coryphaenidae) and billfishes (Istiophoridae) are opportunistic feeders that consume a wide variety of pelagic organisms. When in coastal waters, a substantial portion of their diet may consist of juvenile or larval stages of inshore fishes. Stomachs of blue marlin, yellowfin tuna, and wahoo collected during the 1981 Mariana Fishing Derby contained primarily fishes, most of which were larvae or young of reef-dwelling species. Some of these juvenile fishes were of similar or identical species as those observed aggregating around Guam's Fish Aggregating Devices (FAD). Little else is known about the role of Guam's reef populations in the ecology of the passing pelagic migrants that form the bulk of Guam's offshore fishery.

OBJECTIVES

- I. To obtain additional life history information of reef fish species, which may be applied in assessing these fish populations and formulating fishing regulations.

- II. To determine the feeding habits of pelagic, predator fish associated with offshore aggregating buoys, and identify any feeding changes incurred by this association.
- III. To assess the importance of Guam's reef fish in providing forage for recreationally important pelagic fish.

PROCEDURES

Collection and Preservation

Most stomachs were purchased under contract from the Guam Fishermen's Cooperative, and were dissected either by myself or cooperative personnel. For each specimen, the stomach and if possible, the gonads, were removed and placed in a sealed plastic bag containing an identification number, then frozen for later examination. The species name, fork length, weight, area caught (if known), date caught, and date of removal of stomach were recorded. An effort was made to remove the stomach the same day the fish were caught but this was not always possible. An attempt was made to collect up to 10 stomachs per species per collecting site each day stomachs were taken. This, however, was seldom possible. An attempt was also made to obtain 20 or more samples of each species for each month of the year, but this was rarely possible due to seasonal differences in their availability.

Examination of Stomach Contents and Gonads

After thawing, the contents of each stomach were placed in a shallow tray. Dietary items were sorted to the finest recognizable taxonomic unit, counted, then weighed to the nearest 0.1g after excess fluid was removed. The degree of digestion was estimated for each prey species and certain prey species were measured to the nearest mm. Selected prey items were preserved in either 10% formalin or 70% ethanal for later identification or for comparison with contents of other stomachs. A large reference collection has been organized and is being expanded.

Internal stomach parasites were sorted and counted. Samples of each species were preserved in 10% formalin. Gonads were thawed, weighed (when wet), examined and staged. Selected samples were preserved in 10% formalin.

Analysis of Data

All data are recorded in a form that will allow a number of quantitative and qualitative analyses to be performed. Frequency of occurrence, relative abundance by number and weight, and temporal trends will be analyzed. Specific statistical procedures, tests and indices used will be chosen upon completion of examination of all stomach contents. Choice will be based on usefulness of test results and ease of analysis by available computer facilities.

RESULTS

To date, 628 (45%) of 1398 stomachs collected between December 10, 1981 and January 1, 1983, have been examined (Table 1). Ten or more stomachs have been examined for five of the 16 species considered (Table 2). In all five of these species, fishes occurred more frequently than any other kind of prey. Mahimahi (Coryphaena hippurus) and wahoo (Acanthocybium solandri) fed almost entirely upon fishes, the former primarily upon flying fishes. Wahoo, skipjack tuna (Katsuwonus pelamis), yellowfin tuna (Thunnus albacares) and blue marlin (Makaira nigricans) fed heavily upon larval or post-larval inshore fishes. Yellowfin tuna fed almost as frequently upon crustaceans (primarily larvae and post-larvae) as it did upon fishes, and more frequently upon cephalopods than did any other species. Cephalopods were important in the diets of blue marlin and mahimahi as well. Crustaceans were relatively important in the diets of skipjack tuna as well as yellowfin tuna, but were infrequently eaten by the other species.

A detailed report of the results will be presented in the FY-1983 progress report.

Report prepared by: Robert F. Myers

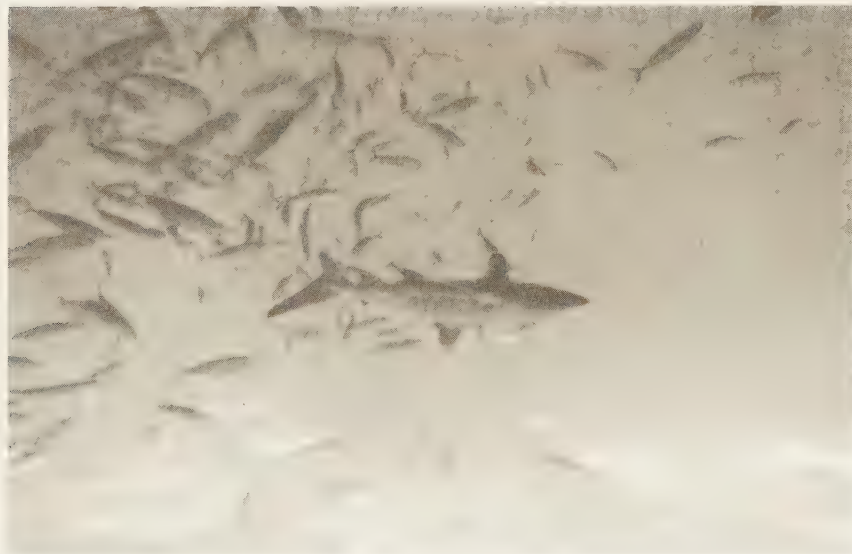


Table 1. Sample sizes of fish stomachs taken during the study period, by month and species.

Species	Total Sample Size	1981		1982		Month & Year							1983 J	Number Examined by 10/1/82	% of Total Examined		
		D	J	J	F	M	A	M	J	J	A	S				O	N
<i>Caranx lugubris</i> *	1		1													2	100.0
<i>Elagatis bipinnulatus</i>	2	1													1	1	50.0
<i>Seriola rivoliana</i>	3	3														3	100.0
<i>Coryphaena hippurus</i>	414	11	66	47	120	100	19	2	12	1	3	2	2	18	13	283	68.4
<i>Aprion virescens</i> *	1		1													1	100.0
<i>Sphyrna barracuda</i>	23	1	2	5												8	34.8
<i>Acanthocybium solandri</i>	231	20	35	13	20	12	10	8	24	5	17	16	36	15	1	100	43.3
<i>Euthynnus affinis</i>	5			2	1	0	1									4	80.0
<i>Gymnosarda unicolor</i>	19	1	2	1	1	1	2			1	8	1			1	8	42.1
<i>Katsuwonus pelamis</i>	316	17	12	18	14	29	38	32	10	47	21	26	34	18	4	130	41.1
<i>Thunnus alalunga</i>	4															0	
<i>L. albacares</i>	292	7	23	8	4	5	36	24	63	29	26	37	7	23	4	72	24.7
<i>Istiophorus platypterus</i>	1															1	100.0
<i>Makaira indica</i>	1							1								0	
<i>M. nigricans</i>	83				4	4	3	31	22	6	6	5	2			14	16.9
<i>Tetrapterus angustirostris</i>	2								1						1	0	
TOTAL	1398	61	142	94	164	151	109	98	132	90	93	87	98	78	1	628	44.9

* These species are primarily associated with the bottomfish fishery, but may also be potential competitors with many pelagic species occurring near reefs or banks.

Table 2. Frequency of occurrence of types of prey in fish stomachs of some of the species examined during 1982.

Species	Number Examined	No. with food in stomach	% of Total with food in stomach	CONTENTS:						Unit or Other No. of Stomachs	% of Total
				Fish Remains	Crustacean Remains	Cephalopod Remains	Remains	% of Total	No. of Stomachs		
<u>Coryphaena hippurus</u>	283	237	83.7	229	21	87	7.4	30.7	10	3.5	
<u>Acanthocybium solandri</u>	100	65	65.0	62	3	17	3.0	17.0	3	3.0	
<u>Katsuwonus pelamis</u>	130	103	79.2	84	43	47	33.1	36.2	18	13.8	
<u>Thunnus albacares</u>	72	71	98.6	65	63	46	87.5	63.4	14	19.4	
<u>Makaira nigricans</u>	14	13	92.9	13	2	7	14.3	50.0			
TOTAL	599	489	81.6	453	132	204	22.0	34.1	45	7.5	

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-19
SUB-PROJECT NO.: F
STUDY NO.: F-II
JOB NO.: 1

JOB TITLE: Limnological Survey of the Major Streams and Rivers

PERIOD COVERED: October 1, 1981 to September 30, 1982

BACKGROUND

The results of previous studies conducted between 1968 and 1980 have been reported in previous DAWR annual reports.

RESULTS

This job was inactive during the period covered due to lack of time and personnel.

RECOMMENDATION

This job should be continued at a relatively low level, to permit periodic limnological surveys to be conducted.

Report prepared by: Alan J. Hosmer

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-19
SUB-PROJECT NO.: F
STUDY NO.: F-II
JOB NO.: 2

JOB TITLE: Masso River Watershed Studies

PERIOD COVERED: October 1, 1981 to September 30, 1982

BACKGROUND

During FY 79, the fauna of Masso Reservoir and its feeder streams was sampled. Aquatic organisms collected include two eels (Anguilla marmorata and A. bicolor), three gobies (Chonophorous guamensis, Microsicydium elegans, and Sicyopterus macrostetholepis) an eleotrid (Eleotris fusca), several shrimps (Atya sp., Caridina sp., and Macrobrachium lar), tadpoles of Bufo marinus, and a variety of insect larvae and small invertebrates.

OBJECTIVES

To formulate fisheries and recreational management plans for present and future reservoirs.

RESULTS

This job was inactive during the period covered due to lack of time and personnel.

RECOMMENDATION

As Masso Reservoir will soon be opened for public fishing, this job should be continued.

Report prepared by: Alan J. Hosmer

GUAM FISHERIES DEVELOPMENT
PROJECT F-2-D-4
Federal Aid in Sport Fish Restoration Act

PROGRESS REPORT
DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-2-D-4
SUB-PROJECT NO.: FD-1

SUB-PROJECT TITLE: Masso Reservoir Development

PERIOD COVERED: October 1, 1981 to September 30, 1982

SUMMARY

Masso Reservoir has been stocked with tucunare, hybrid tilapia and mosquito fish. No information is yet available on the state of the tucunare, however, the latter two species are established and reproducing. Water analyses were performed, and the Management Agreement and fishing regulations were finalized. Erosion and siltation continue to present problems.

BACKGROUND

Fishing continues to be an important activity for many people on Guam. It is highly valued as a recreational activity and remains an important source of food. Saltwater fishing is available but, there is no standing body of freshwater accessible to the general public. If a fishable freshwater pond was available, it would be unique in providing fishing opportunities for all people, including children, senior citizens, and the handicapped who are unable to fish in the ocean where high waves and strong currents are often present.

Masso Reservoir is located near the village of Piti and inland from Apra Harbor. The Reservoir was constructed by the U.S. Navy in the early 1940's for use as a potable water reservoir and was used as such until 1951 when siltation had made it unsuitable for water storage. Vegetational succession continued in the abandoned pond until only $\frac{1}{4}$ to $\frac{1}{2}$ acre of open water existed, surrounded by a marsh of elephant grass (Phragmites karka). In 1978, as part of the DAWR Fisheries Development Program, about two and one half acres of open water was created by removing the elephant grass and dredging the pond to a maximum depth of approximately eight feet. At this time the retaining wall, spillway and sluice gate were repaired. Erosion has continued to be a problem, as much of the watershed has very little vegetation. The occurrence of siltation is very visible within the pond after all but the slightest rains. Repeated efforts have been made to control this erosion by planting thousands of trees and shrubs on the hillsides of the watershed. A detailed description of the major efforts was included in the 1979 DAWR report. Additional plantings were made in 1981. These efforts have only been moderately successful and it is estimated that 10 - 20% of the plants have survived. Poor soil is the primary cause.

Aquatic organisms found in Masso Reservoir and its feeder streams include two eels (Anguilla marmorata and A. bicolor), three gobies (Chonophorous guamensis, Microsicydium elegans, and Sicyopterus macrostetholepis), an eleotrid (Eleotris fusca), several shrimps (Atya sp., Caridina sp., and Macrobrachium lar), tadpoles of Bufo marinus, and a variety of insect larvae and small invertebrates. The vegetation is dominated by the reed Phragmites karka in wet areas, and by Leucaena leucocephala (tangan-tangan) on dry ground. Other trees in the area include Hibiscus tiliaceus, Pandanus sp., Spathodea campanulata (African tulip), Casuarina equisetifolia and Pithecellobium dulce.

In March, 1978, a Draft Environmental Impact Statement (DEIS) for the introduction of exotic fish into Masso Reservoir was submitted to the U.S. Fish and Wildlife Service (FWS). Under this proposal, approximately 20 species of exotic game and forage fish would have been planted. However, the DEIS was reviewed by the FWS and found to be inadequate in its treatment of the potential problems. It was suggested that the required process to complete an acceptable EIS would be far more time consuming and costly than the project warrants. In view of this decision by the FWS, and after considering numerous professional evaluations of stocking, it was decided not to stock the Reservoir with exotic species.

As an alternative to the proposed stocking of exotics, Masso Reservoir is being developed with species of fish already existing on Guam. The program includes hybrid tilapia (Sarotherodon mossambicus X S. nilotica), tucunare or "peacock bass" (Chichla ocellaris) and mosquitofish (Gambusia sp.). Ultimately this combination should provide good recreational fishing for the public. The tilapia are relatively easy to catch and will be particularly well suited to younger fishermen. The tucunare are a much more challenging game fish and should also forage on the tilapia and reduce the common problem of stunted growth in this species. The mosquitofish will provide forage for the two game species.

OBJECTIVES

The objectives of the Masso Project have included the following:

1. Create a pond with several acres of open water suitable for stocking with forage and game fish;
2. Repair the retaining wall, spillway and sluice gate;
3. Create a variety of fish habitats within the pond with brush shelters, rock piles, etc.;
4. Fence in the spillway area to remove an "attractive nuisance" which is potentially dangerous to children and others;
5. Landscape the area around the pond, and plant attractive fruit, shade, and ornamental trees and shrubs;

6. Stock the Pond with fish;
7. Monitor the fish populations in the pond, and the fishermen's use of the pond.

RESULTS

As reported in the 1981 report, 400 hybrid tilapia were stocked in the pond in November, 1981. These fish were removed by vandals using poison and a second stocking of 662 fish was made in May, 1981. Although the hybrid tilapia is predominantly male, and all fish were sexed prior to their release, evidence of reproduction was observed within two months. Subsequent visits have documented active reproduction by this species, and fry and juveniles (of both green and mottled-orange coloration) are consistently seen near the pond margins.

In July and September of 1981 approximately 2,000 Gambusia were collected from the Agana Swamp and released into Masso Reservoir. These fish have now become well established and are abundant in the aquatic vegetation, Limnophilia sp., which grows at the pond's margins.

Fena Reservoir, located on the U.S. Naval Magazine, supports a large, population of tucunare. In July 1981, 23 fingerling tucunare were captured in the Imong River which empties into Fena Reservoir. These fish were held in DAWR's aquaculture tanks until September, to allow the stocked Gambusia to become established and to observe the tucunare for handling mortality. No tucunare were lost to handling stress and in September 1981, 20 of these fish, in addition to 37 caught that month, were transferred to Masso Reservoir. The mean weight of these fish was 50 grams and they averaged 13.6 cm in total length. Although the Reservoir is not yet officially open, occasional fishermen have been catching tilapia using hook and line, baited with earthworms. It is not known if any tucunare have been removed.

On October 21, 1981 William Zolan of the University of Guam, Water Resources Research Center was contracted to perform water analyses for Masso Reservoir. The results are presented in Table 1. According to his evaluation, the Reservoir contained waters that were relatively pure with respect to chemical constituents. Particulates (turbidity, TNFR) were high due to recent rainfall runoff and alkalinity and pH were somewhat elevated, suggesting a spring source of water originating in limestone. Nutrient values (NH₃-N, NO₃-N, PO₄-P) and BOD concentrations were much lower than normally observed in small rivers of southern Guam, however this was probably due to the dilution effect of the recent rainfall and to the aquatic plant assimilation. Dissolved oxygen concentrations were approximately 65% saturated; normal for the morning-hour (0900 hrs.) sampling time.

Table 1. Results of water analyses; Masso Reservoir, Oct. 21, 1981. Values are means of three surface samples taken at north, south and west sides of pond, between 0900 hrs and 1000 hrs.

PARAMETER	MEAN VALUE	PARAMETER	MEAN VALUE
pH	7.6	Total Solids	164 mg/l
Temp.	23.7 °C	Suspended Solids	4.8 mg/l
Turbidity	13.3 NTU	Dissolved Solids	159.3 mg/l
Specific Conductance	253.3 unho/cm	BOD	<.26 mg/l
Dissolved Oxygen, mg/l	5.4 mg/l	Ammonia	.023 mg/l
Total Alkalinity	218.6 mg/l	Nitrate	.002 mg/l
Chloride	9.96 mg/l	Nitrate	.007 mg/l
Sulfate	<1 mg/l	Ortho Phosphate	<.001 mg/l

In anticipation of the Reservoir opening and the need to create access to the open water from the shoreline, an attempt was made to reduce the amount of aquatic vegetation at the pond margins. In March, 1982, a dose of "Round-up" (active ingredient: Isopropylamine salt of glyphosate) was applied from a boat to the emergent leaves of the Limnophilia sp. This and a subsequent application proved unsuccessful.

Regulations for sportfishing in the Reservoir have been formulated. Fishing will be limited to a single, hand-held hook and line. No size limit exists for tilapia, however, not more than ten may be taken per person per day. No tucunare under ten inches may be taken at no more than two per person per day. A Memorandum of Understanding between the Department of Parks and Recreation (DPR) and the Department of Agriculture has been finalized and DPR has been performing grounds maintenance.

RECOMMENDATIONS

Upon the opening of Masso Reservoir, periodic sampling and creel censuses should be conducted to determine the state of the fish stock, and fishing pressure. Occasional restocking of the pond may be necessary. Siltation will continue to be a problem and additional corrective measures should be made.

Report prepared by: Alan J. Hosmer

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-2-D-4
SUB-PROJECT NO.: FD-2

JOB TITLE: Construction of Fish Aggregating Devices

PERIOD COVERED: October 1, 1981 to September 30, 1982

SUMMARY

New mooring systems were fabricated for two previously deployed FAD, and these FAD were redeployed during FY 82. Three buoys were lost this year and to date, one remains on site. Limited data indicate that Guam's FAD are effective in increasing catches, however longevity remains a problem. A General Permit was obtained from the U.S. Army Corps of Engineers, eliminating the need for repeated permit renewal.

BACKGROUND

The DAWR initiated a Fish Aggregating Device (FAD) program in FY 79 with funding from the Pacific Tuna Development Foundation (PTDF). The program continued in subsequent years, and as PTDF funding became depleted more of the program's expenses were derived from Dingel-Johnson (DJ) funds. DJ funds were used almost exclusively during FY 82.

The design evolution of Guam's FAD has closely followed that of the State of Hawaii. The original design utilized foam-filled, 55-gallon drums for floatation and subsequent FAD were constructed of foam-filled tractor tires of two sizes. Mooring systems have been periodically improved with the use of heavier polypropylene line, ball-bearing swivels and rubber-coated splices, shackles and swivels. Detailed descriptions of the design evolution of Guam's FAD and criteria for site selection have been presented in Annual Progress Reports of the DAWR for the years 1979 through 1981.

OBJECTIVES

1. To aggregate recreationally important pelagic fishes at point locations accessible to fishermen.
2. To follow the succession of fishes associated with the FAD.

PROCEDURES

One, Type I FAD ("55-gal drum"), and one, Type II FAD ("large tire"), which had been previously deployed and retrieved after their mooring systems failed, were redeployed during FY 82. New mooring systems were constructed and installed which consisted of 3/4" polypropylene line with a 1:1.1 scope ratio, 1/2" bridle chain, 200 feet of cable at the mooring block, welded and rubbercoated shackles, stainless steel ballbearing swivels, and rubbercoated line splices. A diagram of this mooring system was included in the DAWR FY 81 Progress Report.

Two new sites were selected for the placement of these buoys (Figure 1). Buoy L was deployed on March 13, 1982 at approximate Latitude 13°32.1' N and Longitude 144°36.9' E, or five nautical miles due north of Orote Point. Depth at this location is 1000 fathoms. Buoy M was deployed on March 15, 1982 at approximate Latitude 13°42.6' N and Longitude 144°46.4' E or seven nautical miles northwest of Ritidian Point. Depth at this site is 500 fathoms.

A General Army Corps of Engineers Permit (PODCO-0 GP82-3) was obtained for the deployment of FAD buoys. This permit is valid for a period of ten years and thus eliminates the need for repermitting for each series of deployments. Restrictions on site selection and buoy design remain in effect, and notification of action is required.

Due to time constraints, data collection on the effectiveness of the buoys was limited to occasional visual inspections of the fishes present in conjunction with buoy light replacement, information collected during offshore creel censuses and report cards received from the fishermen using the buoys.

RESULTS

Table 1 presents a summary of FAD deployments since the beginning of the program in FY 79. Eight buoys have been constructed and ten deployments have been made. FAD longevity ranged from 7 to 574 days (the later still on site), with a mean of 162 days. This mean life span is very close to that reported for FAD of various designs, from 26 locations throughout the Pacific Region (157 days), (Shomura and Matsumoto, 1982). Of the nine instances of Guam's FAD breaking loose, we believe all but two were due to failures of the mooring systems. The exceptions were the Cocos Island FAD, which we believe slipped into deeper water and submerged, and the Apra Harbor FAD which undoubtedly was released when a motor vessel severed line scope at the surface. Longevity of Type III buoys, with improved mooring systems, averaged over five times that of the original Type I buoys (347 days vs 65.8 days).

Most of the information pertaining to the effectiveness of FAD is from the period of October 1981 to March 1982. During this time, 38 fishermen reported using FAD via the offshore creel censuses, and an additional 29 returned catch reports to the DAWR office. The results of these reports are presented in Table 2. For comparisons, a summary of the offshore, non-FAD, creel census interviews is included. It must be noted that differences in sample sizes, origins of the data, and sampling biases preclude direct comparisons of the data, however, qualified evaluation

of the FAD is possible. Also, given the seasonality of Guam's offshore fisheries, and variation in the effectiveness of the FAD on fish species, the results presented here would be expected to vary seasonally.

The Facpi Point, Haputo Point, and Camel Rock buoys were on site during all or most this period and the Apra Harbor buoy was present during the first half of March, (Table 1). Information from all buoys was combined for analysis.

A total of 162 non-FAD fishing trips were recorded during this period (Table 2). These trips originated from the Agana Boat Basin and included boats trolling the nearshore waters of Guam as well as the more productive offshore banks. It is possible that a few FAD fishing trips were not identified as such, and also included in this figure. Thirty-eight, confirmed, FAD fishing trips were recorded, representing approximately 19% of all fishing trips recorded during the period. In most instances, boats fishing the FAD also fished other areas during the trip, or at least to and from the FAD. Comments from fishermen have indicated that a greater number of FAD would result in much greater usage. Apparently, fishermen are reluctant to fish the FAD if other boats are already present, or immediately after it has been heavily fished and "cleaned out" by other boats.

For non-FAD fishing trips, the average catch per boat hour (excluding travel time) was 6.87 Kg. In comparison, interviewed FAD fishermen averaged 9.47 Kg per boat hour, or approximately 27% greater catches. In calculating these values, only actual or derived fishing times were used, and due to the proximity of the FAD to launch sites it is likely that calculation of catch rates based on total trip time would favor the FAD even further. Derived fishing times were calculated by multiplying the number of trolling passes made, by the average of 10 minutes per pass.

Of the 29 FAD catch reports submitted to our office, 17 were for Haputo Pt., eight for Facpi Pt. and four for Camel Rock. Of these reports, seven indicated no catch and the greatest was 739 Kg for one trip. The mean CPUE value was 85.1 Kg per fishing hour. Several factors undoubtedly contributed to this extraordinarily high catch rate. First, most of the records were received during the month of November when overall, offshore fishing was good. Likewise, catches of the seasonal mahimahi and wahoo are generally good during much of this 6 month period, and the FAD appear to be most effective in aggregating these pelagic, surface-oriented fishes. Secondly, the small, nonrandom sample was dominated by reports from a few very proficient fishermen who made large catches. Therefore, this figure may approximate optimal catch rates obtainable at the FAD.

RECOMMENDATION

The above results, as well as the opinions of fishermen, indicate that the buoys are effective in aggregating fish at point locations and in increasing catches. However, until FAD longevity can be increased, the cost effectiveness of the program is questionable. It is, therefore, recommended that further construction and deployment of FAD in Guam's waters be delayed until technological improvements in the mooring system are realized. Considerable effort is being directed toward this in

Hawaii and elsewhere, and improvements are pending. Once achieved the DAWR should proceed with a large scale program, in which several (10-12) FAD are simultaneously constructed. Such large scale production and deployment would reduce the cost per unit substantially. At that time an individual should be hired solely for this project to permit its timely execution.

Funding for such a program will remain an obstruction. It is recommended that a concerted effort by DAWR and local sports fishermen be promoted to lobby the Government of Guam for project funds. If successful, such a program may significantly benefit the local recreational fishing industry in Guam.

REFERENCES CITED

Shomura, R.S. and W.M. Matsumoto. 1982. Structured Flotsam as Fish Aggregating Devices. NOAA Technical Memorandum, October 1982. NOAA-TM-NMF-SWFC-22. 9p.

Report prepared by: Alan J. Hosmer and Robert F. Myers





Figure 1. Approximate locations of Guam's FAD, 1979-1982.

Table 1: Locations, deployment dates and longevity of Fish Aggregating Devices (FAD) in Guam FY'79-82.

<u>Location</u>	<u>FAD Design*</u>	<u>Depth (Fathoms)</u>	<u>Date Deployed</u>	<u>Approximate Date Lost</u>	<u>Longevity (days)</u>	<u>Latitude (Approximate)</u>	<u>Longitude (Approximate)</u>
Buoy A : Facpi Pt.	I	570	12/8/79	12/14/79**	7	13°20.2'N	144°36.4'E
Buoy A : Facpi Pt.	II	570	4/24/80	9/13/80**	142	13°20.2'N	144°36.4'E
Buoy A : Facpi Pt.	III	570	5/18/81	7/10/82	226	13°20.2'N	144°36.4'E
Buoy B : North End	I	200	6/23/80	9/13/80	82	13°43.1'N	144°53.7'E
Buoy H : Cocos Island	III	600	5/18/81	Believed Sunk	-	13°14.0'N	144°37.4'E
Buoy J : Haputo Pt.	I	500	1/30/80	5/5/80	94	13°37.1'N	144°46.5'E
Buoy J : Haputo Pt.	III	500	7/17/81	On Site as of 1/31/83	574	13°57.1'N	144°46.5'E
Buoy K : Camel Rock	III	500	7/16/81	3/15/82	242	13°14.0'N	144°37.4'E
Buoy L : Apra Harbor	II	1000	3/13/82	3/30/82	15	13°32.1'N	144°36.9'E
Buoy M : Ritidian	I	500	3/14/82	6/1/82	80	13°42.6'N	144°36.9'E

*Design I = Triple 55-gal drum buoy; II - Large Tire Buoy; III - Small Tire Buoy
 **Buoy Retrieved

Aquaculture
(Public Law 88-309 Matching Funds)

PROJECT TITLE: Development of Tropical Polyculture Fish Farming

PERIOD COVERED: October 1, 1981 through September 30, 1982

FUNDING SOURCE: National Marine Fisheries Service (P.L. 88-309)
Government of Guam

SUMMARY

The Division of Aquatic and Wildlife Resources continued work with the development of aquaculture on Guam during FY 82. Technical assistance and information were provided to people involved in aquaculture. The warm-water fish rearing facility designed for the production and development of culture techniques was completed. A study was conducted using hormone injection in Thai Catfish, Pangasius sutchi, to achieve egg maturation.

EXTENSION

The island's primary extension effort is with the University of Guam Extension Service. However, during the past year, we visited with many people interested in the development of aquaculture and detailed technical information was provided to them (Table 1). Catfish and tilapia culture held the primary interest among the visitors. Also, the culture methods of shrimp, prawns, carps and eels were discussed. School tours were implemented at the Department so children would become aware of our work in agriculture and aquaculture.

Table 1. People given Technical Aquaculture Assistance from October 1, 1981 to September 30, 1982.

Name	Location	Affiliation	Interest
Miguel Quitugua	Talofofo	Personal	Catfish
David Giusti	Inarajan	Personal	Catfish
Vangie Charfauros	Agat	Personal	Catfish
George Tsai	Inarajan	Aquaculture Enterprise, Inc.	Tilapia & Shrimp
Don San Agustin	Saipan	Personal	Aquaculture
Chris Torrie	Fonte	Personal	Carp & Catfish
Joe Quinata	Tamuning	Personal	Prawns & Catfish
Joe Quitugua	Sinajana	Personal	Backyard Pond
John Lin	Tamuning	Personal	Tilapia
Joe Baza	Merizo	Personal	Prawns & Carp
John Pillsbury	Saipan	Personal	Tilapia & Eel
Margaret Pelowski	Mangilao	Personal	Backyard Pond & Tilapia
Francisco Pangelinan	Mangilao	Personal	Tropical Fish & Guppies
Ms. Linda Crews	NAS Little Red School	DOE	Tour
Ms. Elaine Aguon	Talofofo Elementary School	DOE	Tour
Ms. Beverly Brumeau	St. John School	DOE	Tour
Frank Leong	Tamuning	Real Estate 1	Eels
Dr. Joe Dizon	Yigo	Personal	Aquaculture
Dr. Larry Lawcock	Guam Community College, Mangilao	-	Tour
Jerry McDonald	Fonte	Personal	Aquaculture
-	Little Red School	DOE	Tour
	NAVCAMS	DOE	Tour
James Sablan	Agana Heights	Personal	Aquaculture
Dr. Larry Lawcock	Talofofo	Personal	Aquaculture
Eusebio Casta	Philippines	Personal	Fry Production & Fish Growout

Table 1. Continued

Name	Location	Affiliation	Interest
So Khim	Philippines	Personal	Fry Production & Fish Growout
So Gonzalo	Philippines	Personal	Fry Production & Fish Growout
Ms. Cathy Fish	Harvest School - Toto	-	Tour
Fred Mendiola	Talofofo	Personal	Catfish
Orlando Chapman	Mongmong	Personal	Aquaculture
Kel Steiner	Saipan	Youth with a Mission	Tilapia & Catfish
Joe Santos	Piti	Personal	Catfish
Danny Santos	Piti	Personal	Catfish
Mike Ogo	Tai	Personal	Catfish
Greg Rodriguez	Agana	Public Market Aquaculture Proj.	Aquaculture
Ms. Strandhgan	Agueda Johnson Jr. High School	DOE	Tour
Leonard Paulino	Talofofo	Personal	Tilapia
-	Andersen Elementary School, AAFB	DOE	Tour
Bill Johnston	Agana	Fishermans Cooperative	Aquaculture
Joe Camacho	Toto	Personal	Catfish
Tom Babauta	Agat	Personal	Catfish
John Salas	Mangilao	Personal	Guppies
Sargent Hernandez	Mangilao	Personal	Aquaculture
Summer Youth	Talofofo	Government	Tour
Bob Wood	Harmon	EPA	Aquaculture
Felix Quan	Agana	Farmer's Cooperative	Aquaculture
Gary Swedlock	Andersen Air Force Base	Personal	Aquaculture
Steven Marino	Andersen Air Force Base	Personal	Aquaculture
Rupert Imanura	Hawaii	FmHA	Aquaculture
Martirez Payba	Guam	FmHA	Aquaculture
Isabelo Lazarte	Tamuning	Personal	Tilapia
Brownies Troop 72	-	-	Tour
Dan Matsuno	Barrigada	Personal	Aquaculture

Table 2. Round Tanks and Rearing Troughs at Fish Rearing Facility,
Department of Agriculture, Mangilao, Guam

ROUND TANKS				
Number of Tanks	Material	Gallons	Height (Inches)	Diameter (Inches)
4	Fiberglass	200	16	64
4	Fiberglass	300	24	60
1	Fiberglass	550	30	72
3	Fiberglass	1050	36	96
4	Plastic	130	35	36
4	Plastic	260	44	46

REARING TROUGHS					
Number of Tanks	Material	Gallons	Height (Inches)	Width (Inches)	Length (Inches)
8	Fiberglass	33	6	12	108
2	Fiberglass	100	12	22	96
8	Fiberglass	50	12	22	48
4	Metal With Plastic Lining	50	11	23	68

Construction of Fish Rearing Facility

Formal construction of the new fish rearing facility was completed in June, 1982. Considerable time was devoted by Division personnel to the determination of design and overseeing the actual construction. Additional effort is required to complete tank placement and plumbing, however. The facility is now partially functional and was used for the Thai catfish production experiment.

The new facility is intended for the development of culture techniques and production of tropical freshwater fish that have economic potential on Guam. It was designed primarily for the Thai Catfish (Pangasius sutchi), local catfish (Clarius macrocephalus), hybrid tilapia (Sarotherodon mossambicus x S. niloticus) and local tilapia (Sarotherodon mossambicus). Modifications could be made to culture grass carp, Ctenopharyngodon idellus, silver carp, Hypophthalmichthys molitrix, big head carp, Aristichthys nobilis, and topminnow, Gambusia affinis.

The fish rearing facility is located next to the Fish & Wildlife Laboratory at the Department of Agriculture. It consists of a 40' x 40' terrace placed on a terrain of approximately 6.5 percent slope. Retaining walls made of cement hollow blocks, reinforced with rebars and filled with concrete border 3 sides. The inner portion was filled with coarse sand and walls opposite the terrace were backfilled with coarse gravel, covered with soil, and planted with grass to prevent erosion. A galvanized metal pipe frame with a pitched roof covers the terrace. A black shade cloth is tied to the frame. The facility has six 150 watt flood lights, four waterproof electrical outlets conduits, a one-inch main water supply line with two valved outlets and four three-fourths inch hose bibb outlets. One four inch PVC drain pipe is located at the center with four tee inlets for water drainage from the rearing troughs and round tanks (Table 2). As presently designed the facility has a total capacity of 8,324 gallons.

Development of Culture Methodology for Thai Catfish, Pangasius sutchi

SUMMARY

Thai catfish, Pangasius sutchi, showed a limited, positive response to hormone injections during an oogenesis induction study. Synthroid, estradiol and carp pituitary were used for hormone injections. At the end of the study, cream-colored, free-flowing eggs occurred in three treated fish and the rest had regressed eggs.

BACKGROUND

Thai catfish, Pangasius sutchi, has potential for being a cultured food fish on Guam. Viable eggs and fry, for growth to fingerling stage, are needed to realize the goal. In 1975, catfish fry were given to the Division and the broodstock have been reared in cement holding tanks. Last year, selected catfish were injected with carp pituitary and human chorionic gonadotropin to cause ovulation; but, the eggs were immature and continued injections with the hormones did not cause egg maturation (Kruckenberg, 1981). Research has shown that estrogen, thyroxine, and the pituitary gland play an important role in the egg-yolk development for a limited number of cultured Asian fish (Lam, 1982, Harvey and Hoar, 1979, and Davy and Chouinard, 1981). Research was needed to find proper doses and injection frequency to achieve yolk production in catfish eggs and subsequent ovulation. It is our understanding that this has not been attempted previously for the Thai catfish. Most of the production work done in Asia with the Thai catfish has been with fully mature fish having viable and ripe eggs.

OBJECTIVES

1. To induce oogenesis and egg release in the Thai catfish.
2. To develop the hatchery procedures for rearing the Thai catfish from egg to fingerling stage.

PROCEDURE

Three round, 3,970 liter fiberglass tanks with flow through water systems were used to hold the catfish during the experiment. Seven female catfish, with a mean weight of 3.1 kg, were placed in each tank. The fish in Tank A served as a control, while those in Tanks B and C were given hormone treatments. The fish were fed once daily a combination of ground tuna and 28% protein feed.

Tank A

Each of the fish in this control tank were injected eight times with .68 ml of a .9% saline solution, over a 13 day period (Table 3). A one cc syringe with a No. 22 needle was used for each injection. On the eighth day, two of the fish were sacrificed and the gonads examined. All the fish in this tank were sacrificed on the 14th day.

Tank B

The fish in this tank were injected with a mixture of .25 ml (10 mg) of estradiol and .20 ml (20 mcg) of synthroid once every other day during a seven day period. The hormones were combined into a one cc syringe with a No. 22 needle for each injection. On the eighth day, one of the fish was sacrificed and the gonads examined. On the ninth day, a mixture of .25 ml (10 mg) of estradiol and .25 ml (5 mg) of carp pituitary was injected into each of the fish in this tank. On the 11th day, a combination of estradiol .25 ml (10 mg) and a higher concentration of carp pituitary (.25 ml (20 mg)) was injected into each of the fish in this tank once a day for three consecutive days (Table 3). On day 14, all of the fish in this tank were sacrificed for gonadal examination.

Tank C

The catfish in this tank were injected in the same manner, with the same combination of hormones, and at the same frequency as those in Tank B. However, during each of the three series of injections, the fish in Tank C received twice the dosage of hormones, as those in Tank B (Table 3). On the eighth day, one of fish was sacrificed and the gonads examined. All the remaining fish in the tank were sacrificed on day fourteen.

RESULTS

Prior to the study, three female catfish were randomly selected from our broodstock and sacrificed to examine the condition of the gonads. Two catfish had abundant white eggs, while the third had dark red regressed ovaries. It was noted that the eggs of these two examined fish were more abundant and more developed than those examined last year during this season. This may be due to the ground tuna added to their diet of 28% protein feed subsequent to last year's study. At the end of the study, the mean weight of all the ovaries was 26.1 grams.

Tank A

On the eighth day, two catfish were sampled. The first fish was a male mistaken for a female due to the large layers of muscle and fat tissue in the ventral region. The second catfish had abundant, well-developed white eggs. At the end of the study, all the catfish injected with saline solution had normal red-brown colored livers, no liquid in the body cavities, regressed ovaries, and minimal water in the stomach.

Tanks B & C

On the eighth day, one fish was sampled from each tank. Each had abundant well developed white eggs. An enlargement of the ventral region of the fish was noted after nine days. All the catfish in both tanks receiving hormones developed enlarged yellow-green livers, yellow fluid in the body cavities, and enlarged stomachs containing water. Upon final examination, one fish from Tank B and two from Tank

Table 3. Hormone Injection Schedule for Thai Catfish, Pangasius sutchi, From July 2 - 14, 1982 at Department of Agriculture, Mangilao, Guam.

Dates Injected	Tank	INJECTION			
		.9% Saline Solution	Estradiol	Synthroid	Carp Pituitary
July 2,4,6,8, 1982	A	.68 ml.			
	B		.25 ml (10 mg)	.20 ml (20 mcg)	
	C		.50 ml (20 mg)	.40 ml (40 mcg)	
July 10, 1982	A	.68 ml.			
	B		.25 ml (10 mg)		.25 ml (5 mg)
	C		.50 ml (20 mg)		.50 ml (10 mg)
July 12, 13, 14, 1982	A	.68 ml.			
	B		.25 ml (10 mg)		.25 ml (20 mg)
	C		.50 ml (20 mg)		.50 ml (40 mg)

C had free-flowing eggs. These eggs had progressed from well developed white eggs to cream-colored, free-flowing eggs. Of the three fish, one from each tank had particularly enlarged ventral regions with a large volume of yellow fluid in the body cavity. The remainder of the fish had regressed eggs. On the last day an attempt was made to fertilize the cream-colored eggs with milt from a male catfish; but, was unsuccessful.

DISCUSSION

The same hydration of the ventral region that we observed after nine days has been documented for the cichlid, Tilapia niloticus (Babiker and Ibrahim, 1979), ayu, Plecoglossus altivelis (Hirose and Ishida, 1974) and grey mullet, Mugil cephalus L. (Nash and Shehadeh, 1980) that were injected with similar hormones which caused successful ovulation. Additionally, the eggs of three fish progressed from well developed white eggs to cream-colored, free-flowing eggs. It would appear from these results that the hormones had at least a limited positive effect on some of the fish.

Last year, four of the eighteen fish died during the study. This year no mortalities occurred and may be attributed to better handling techniques and a reduction of stress.

All but three fish in this study developed regressed ovaries. This may have been caused by a reaction to the injections themselves or the handling stress within the tank. The regressed ovaries may also indicate that the levels of estradiol were too high and should possibly be lowered because research has shown that a high dose of estrogen may cause ovarian regression in the Asian catfish, Heteropneustes fossilis Bloch (Anand and Sundararaj, 1974). The injections, handling stress, type of hormone, dose and frequency of injection, and degeneration of ovary prior to injection are all factors that could cause ovarian regression.

RECOMMENDATIONS

The hormone injection research was set up in two phases: (1) Estrogen - thyroid and (2) estrogen - carp pituitary. Next year, the injection schedule should be set up in three phases: (1) thyroxine - gonadotropin (2) thyroxine - estrogen and (3) carp pituitary. The thyroxine and gonadotropin should be injected first because it is believed that they assist an ovarian development and in the formation of the yolk vesicles within the ovary. Then, estrogen should be introduced, which is thought to cause an increase in the plasma level of vitellogenin, a yolk protein precursor produced by the liver; but, does not cause the incorporation of vitellogenin into yolk granules within the oocyte. It has been suggested that the latter is dependant upon the pituitary factor and plays a role in the preparation of eggs for ovulation upon ripening.

After reviewing our results, the estrogen levels could be reduced to test ovarian response. The carp pituitary should be injected after the ventral swelling occurs to assist the eggs in ripening to maturity and ovulation. Periodic early sampling of female catfish in April, May and June would give us needed knowledge on the development of the eggs and may allow us to begin the injections during the proper egg development stage. Preparatory work in procuring hormones, supplies, and net repair should be done well in advance of the season to insure the readiness for the research work.

Other Activities

The local aquaculture industry has shown a strong interest in the local catfish, Clarius macrocephalus, because of the apparent high marketability. The catfish were located and collected from Chalan Pago, Talofofo and Piti. They were placed in our fiberglass tanks, fed ground tuna and have exhibited good growth. When developed, they will serve as broodstock for future culture work. Next year, another attempt will be made during the dry season to find local catfish with a weight of at least 120 grams. David Giusti at Inarajan, received fifty of the Division's surplus male Thai catfish, Pangasius sutchi, for pond growout. Five pickup loads of chicken manure fertilizer were hauled to the U.S. Navy Fuel Depot Pond, which contains broodstock for future fisheries research.



LITERATURE CITED

- Anand, T. C. and B. I. Sundararaj. 1974. Temporal Effects of Artificial Induction of Ovulation on the Hypothalamo-Hypophyseal-Ovarian System of the Catfish, Heteropneustes fossilis (Bloch). Neuroendocrinology 15:158-171.
- Babiker, M. M. and H. Ibrahim. 1979. Studies on the Biology of Reproduction in the Cichlid Tilapia nilotica L.: Effects of Steroid and Trophic Hormones on Ovulation and Ovarian Hydration. J. Fish Biol. 15:21-30.
- Davy, Brian F. and Amy Chouinard. 1981. Induced Fish Breeding in Southeast Asia: Report of a Workshop held in Singapore, 25-28 November 1980. IDRC-178e. IDRC, Ottawa, Ontario. 48 p.
- Harvey, B.J. and W.S. Hoar. 1979. Theory and Practice of Induced Breeding in Fish. IDRC-TS21e. IDRC, Ottawa, Ont. 48 p.
- Hirose, Keiji and Rikizo Ishida. 1974. Effects of Cortisol and Human Chorionic Gonadotrophin (HCG) on Ovulation in Ayu, Plecoglossus altivelis (Temminck & Schlegel) with Special Respect to Water and Ion Balance. J. Fish Biol. 6:557-564.
- Kruckenbergh, Wayne L. 1981. Annual Report Fiscal Year 1981. Aquatic & Wildlife Resources, Department of Agriculture. pp. 99-102.
- Lam, T.J. 1982. Applications of Endocrinology to Fish Culture. Can J. Fish Aquat. Sci. 39:111-137.
- Nash, C.E. and Z.H. Shehadeh. 1980. Review of Breeding and Propagation Techniques for Grey Mullet, Mugil cephalus L. ICLARM Studies and Review 3. International Center for Living Aquatic Resources Management, Manila, Philippines. 87 p.

GUAM WILDLIFE INVESTIGATIONS
PROJECT FW-2R-19
Federal Aid in Wildlife Restoration Act

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-19

SUB-PROJECT NO.: W-1

STUDY NO.: 1

JOB NO.: 1

JOB TITLE: Determination of Current Population Size and Distribution of
Guam Deer.

PERIOD COVERED: October 1, 1981 to September 30, 1982.

SUMMARY

Hunting license sales increased slightly this year. An estimated 67 deer were taken during the season. Northwest Field (NWF) and Naval Communication Area Master Station (NCS) were the most popular hunting areas. Analysis of spotlight count data indicated a non-significant increase in deer numbers at Andersen Air Force Base (AAFB) and a non-significant decrease on Naval Magazine (NAVMAG).

BACKGROUND

The Guam deer has been under investigation by the Division of Aquatic & Wildlife Resources since 1961. Its distribution, population trends and biology have been described by Wheeler (1979). Deer hunting statistics have been compiled since 1968 through hunter reporting procedures.

OBJECTIVES

To determine the current size and distribution of the population of deer on Guam and to monitor population trends.

PROCEDURES

1. Continue monthly spotlight counts on Naval Magazine and Andersen Air Force Base, with periodic spotlight counts in other areas.
 - a. Record number, age, sex and group composition.
 - b. Statistically analyze count data and compare with past data to discern population trends.

2. Investigate the feasibility of using additional census methods, such as pellet group counts, to refine population estimates and knowledge of distribution.
 - a. Conduct surveys and censuses in areas such as the Bolanos Conservation Area, where spotlight counts are not feasible.
 - b. Attempt to correlate spotlight count data with actual deer abundance on AAFB by determining the change in sex ratio after buck-only special hunts.
 - c. Attempt to determine a pellet group index that may be used to estimate deer abundance and/or habitat utilization.
3. Collect hunting statistics by requiring hunters to return hunter report cards. Analyze these statistics for changes in hunter kill, hunter effort and kill locations.

RESULTS

Deer Hunting Statistics

Hunting license sales for all game species increased by 7.5% from FY 1981 to a total of 358 licensed hunters. Hunting was restricted to antlered deer only during October through December, with a season bag limit of one animal.

Forty-three hunters returned their report cards (12.0% return), and of these, 26 (60.5%) indicated that they had hunted deer (Table 1). Eight deer were reported taken by these hunters in the following areas: NCS (4), NWF (3) and Anao (1). Estimates based on report cards indicated that 217 hunters participated in the hunting season and that 67 deer were taken. These figures are slightly higher than island-wide harvest estimates for previous years (AWRD 1979, 1980, 1981). Of 20 hunters who supplied information on their number of hours spent hunting, 65% indicated that they had hunted at NWF and 45% at NCS, making these military lands the most popular areas on the island in which to hunt deer (Table 2). Hunter logs were maintained throughout the season at these military installations and hunters were required to sign in and out and report any game taken. The combined number of sorties made by gun and bow hunters were similar for both bases (Table 3). A total of five deer were reported taken at NWF and two at NCS. Of non-military areas, the Tarzan and Anao Conservation Reserves had the greatest reported number of hunters (Table 2). Limited access due to bad roads and poorly demarcated boundaries were probably the major reasons for discouraging more hunters from using the territorial conservation areas.

Table 1. Island-wide deer hunting statistics, FY 1982.

a. Total license sales for all game species	358
b. Number of Hunter Report Cards returned	43
c. Percent of Hunter Report Cards returned	12.0%
d. Number of reporting hunters who hunted deer	26
e. Percent of reporting hunters who hunted deer	60.5%
f. Number of deer taken by 26 hunters	8
g. Hunter success ($f \div d$)	30.8%
h. Estimated total number of legal deer hunters (axe)	217
i. Estimated total legal deer take (gxh)	67
j. Number of 8-hour hunter days expended by 20 reporting deer hunters	149
k. Average number of 8-hour hunting days spent per reporting deer hunter ($j \div 20$)	7.5
l. Estimated total number of deer hunter days (hxk)	1628
m. Number of 8-hour hunter days per deer taken ($l \div i$)	24.3

Table 2. Island-wide distribution of deer hunting pressure based upon report cards returned by 20 hunters, FY 1982.

Hunting Locations	Number of Hunters	Number of Hunter Hours	Number of Deer Taken
NWF	13	750	3
NCS	9	363	4
Tarzan	2	36	0
Anao	2	28	1
Others	2	14	0

Table 3. Hunter effort and deer take based on official hunter logs from NCS and NWF, FY 1982.

	NCS				NWF			
	#Gun Sorties	#Bow Sorties	<u>Deer Take</u> Gun Bow		#Gun Sorties	#Bow Sorties	<u>Deer Take</u> Gun Bow	
October	353	19	1	-	392	5	4	-
November	236	36	-	-	324	1	-	-
December	244	40	1	-	202	0	1	-
TOTAL	833		2		924		5	
Total Hunter-Hours	3166				3459			
Total Hunter-Days	396				432			



Table 4. Composition of deer herd seen during spotlight counts at Andersen Air Force Base, FY 1982.

	1981					1982							TOTAL	AVE. NO. COUNT	ST. DEVIATION
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP			
Unclassed Buck	4	1	2	4	3	1	7	1	1		2	3	29	12.1	3.87
Spike	3			4	1	3	1	2	2	1	2	3	22		
2 PT	6	1	6		1		2	2	2	2	4	1	27		
3 PT	2	1	7	3	5	6	4	6	9	6	8	9	66		
4 PT			1										1		
Doe	14	7	28	29	37	23	37	19	33	29	42	39	337	28.1	10.65
Yearling	2	1		4	4	1	4	1	11	3	2	3	36	3.0	2.86
Fawn		1	4	4	5	3	7	4	3	5	5	4	45	3.8	1.86
Unclassed Deer	24	7	24	10	34	10	18	22	14	28	22	21	234	19.5	8.02
TOTAL	55	19	72	58	90	47	80	57	75	74	87	83	797	66.4	20.26
Km Traveled	6.9	6.6	6.8	7.4	7.6	6.9	7.6	7.4	6.9	6.9	7.4	7.6	81.0	7.2	0.37
Deer / 10 Km	79.7	28.8	105.9	78.4	118.4	68.1	105.3	77.0	108.7	107.2	117.6	109.2	1104.3	92.0	26.38
Deer / 10 Miles	127.9	46.3	171.4	126.1	191.5	109.3	170.2	123.9	174.4	172.1	189.1	176.6	1781.1	148.4	41.92

Table 5. Composition of deer herd and number of water buffalo seen during spotlight counts at Naval Magazine, FY 1982.

	1981					1982												AVE. NO. COUNT	ST. DEVIATION
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL						
Unclassed Buck		1	1				3		1		2	1	9						
Spike	1				1	1	2						5						
2 PT					1		1		2	1		1	6	2.3	1.63				
3 PT	2			2	1	1			1		1		8						
4 PT													0						
Doe	7	5	5	5	16	8	10	13	11	6	7	7	100	8.3	3.50				
Yearling	1	1			1	2			4		1		10	.8	1.19				
Fawn	2		2	1	5	4		1	2	4			21	1.8	1.76				
Unclassed Deer	8	5	8	3	5	6	15	3	4	2	12	3	74	6.2	3.97				
TOTAL	21	12	16	11	30	22	31	17	25	13	23	12	233	19.4	7.00				
Km Traveled	21.6	22.2	21.1	22.2	22.7	21.9	22.7	22.7	22.7	24.3	22.2	22.7	269.0	22.4	0.78				
Deer / 10 Km	9.7	5.4	7.6	5.0	13.2	10.0	13.7	7.5	11.0	5.3	10.4	5.3	104.1	8.7	3.11				
Deer /10 Miles	15.7	8.7	12.2	8.0	21.3	16.2	22.0	12.1	17.7	8.6	16.7	8.5	167.7	14.0	5.01				
Water Buffalo	53	73	62	45	70	48	66	35	66	42	62	76	698	58.2	13.25				

Spotlight Count Trends

Monthly spotlight count data at AAFB (Table 4) and NAVMAG (Table 5) were analyzed and compared with the previous year by using the Mann-Whitney U-Test (Table 6) (Sokal and Rohlf 1969). The FY 1982 count data from AAFB were substantially higher but not significantly different from FY 1981. An average of 66.4 deer were seen per count in FY 1982, an increase of 40% over FY 1981. During FY 1982, the Air Force began to notice increasing numbers of deer on the base's runways. This further confirms that the current population in the Pati Point area has grown during the past several years and now represents a potential safety hazard to aircraft. In order to alleviate this problem, a special either-sex hunt has been proposed for the eastern side of Pati Point in December 1982.

Data gathered during spotlight counts at NAVMAG showed a non-significant decrease with the mean number of deer observed per count dropping from 25.1 in FY 1981 to 19.4 in FY 1982 (Table 6). Three counts were also conducted at NCS during August in order to measure pre-hunt abundance. Only one deer was observed there during a total of 44 km of spotlighting. Heavy poaching pressure is probably the major cause for the small size of the deer populations on each of these bases.

Table 6. Comparison of deer and water buffalo spotlight counts at Andersen Air Force Base and Naval Magazine between Fiscal Years 1981 and 1982. Significant differences between years were determined with the Mann-Whitney U-Test.

	deer				water buffalo	
	AAFB		NAVMAG		NAVMAG	
	FY 81	FY 82	FY 81	FY 82	FY 81	FY 82
No. Counts	10	12	10	12	10	12
Maximum No. of Animals Observed/Count	66	90	41	31	93	76
Mean No. of Animals Observed/Count	47.5	66.4	25.1	19.4	36.9	58.2
Std. Deviation	+ 9.50	+ 20.26	+ 11.14	+ 7.00	+ 27.97	+ 13.25
Coefficient of Variation (%)	- 20.0	- 30.5	- 44.4	- 36.1	- 75.8	- 22.8
Significant Difference	N.S.		N.S.		SIG.*	

* - Counts during FY 1982 were significantly higher ($p < .01$) than in FY 1981.

Spotlight counts are not a sensitive indicator of deer population levels and substantial changes in population level must occur before significant changes are detected. Manpower shortages in FY 1982 have precluded the possibility of intensified sampling with additional spotlight counts as recommended in the previous reports.

Feral Asiatic Water Buffalo

Water buffalo (carabao) were observed during all of the deer spotlight counts at NAVMAG in FY 1982. A significant increase ($p < .01$) in buffalo numbers was noted with mean number of 58.2 animals seen per night and a maximum single night count of 76 (Table 5). These data indicate that the water buffalo populations at NAVMAG is still continuing to increase in size (AWRD 1979, 1980, 1981).

RECOMMENDATIONS

Increase the effort directed at determining the size of deer populations in other areas of the island. Further explore the application of pellet group counts and other methods as indices of deer abundance.

LITERATURE CITED

- Aquatic and Wildlife Resources Division. 1979-1981. Job Progress Reports. -Federal Aid to Fish and Wildlife Restoration, Department of Agriculture, Government of Guam, Agana, Guam.
- Sokal, R.R. and F.J. Rohlf. 1969. Biometry. W.H. Freeman and Co., San Francisco. 776 pp.
- Wheeler, M.E. 1979. The biology of the Guam deer. Aquatic and Wildlife Resources Division Technical Report No. 3, Department of Agriculture, Government of Guam, Agana, Guam. 53 pp.

Report prepared by: Gary J. Wiles

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-19

SUB-PROJECT NO.: W-1

STUDY NO.: 2

JOB NO.: 1

JOB TITLE: Preparation of a Status Report on Wild Pigs

PERIOD COVERED: October 1, 1981 to September 30, 1982

OBJECTIVES

To prepare a status report on wild pigs to be used in planning future work.

RESULTS

This job was inactive during this segment due to shortage of staff.

RECOMMENDATIONS

This job should be implemented in Segment 20 if adequate manpower is available.

Report prepared by: Robert D. Anderson



JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-19

SUB-PROJECT.: W-1

STUDY NO.: 2

JOB NO.: 2

JOB TITLE: Population Size and Distribution of Wild Pigs on Guam

PERIOD COVERED: October 1, 1981 to September 30, 1982.

SUMMARY

An estimated 266 pig hunters took an estimated total of 389 animals. Northwest Field (NWF) and Naval Communications Area Master Station (NCS) were the most popular hunting areas.

BACKGROUND

The wild pig (Sus scrofa) is one of Guam's two game mammals. The wild pigs on Guam descend from stock introduced by the Spanish during their 300-year role on the island. Wild pigs are found island-wide, though appear to be most numerous in the limestone forests of the north and the ravine forests of southern Guam.

Fieldwork on pigs in the past has been concentrated on military lands. There is a need to assess pig populations in other areas of the island, particularly in the south, where pigs may be under-harvested and where crop damage by pigs is a common complaint.

OBJECTIVES

To determine current population size and distribution and to monitor trends.

PROCEDURES

1. Record pig sightings during deer spotlight counts, and observations of pigs or pig sign during other fieldwork.
2. Conduct surveys using sign counts, flushing counts, or other methods, to determine the relative abundance of pigs in the Bolanos Conservation Area.
3. Monitor the harvest of pigs during the legal hunting season.

RESULTS

Pig Hunting Statistics

Hunting season for wild pigs ran from October through December, with a season bag limit of 10 animals. The estimated total number of pig hunters in FY 1982 was higher than in FY 1981 (AWR 1981), with 74.4% of the hunters who returned their report cards indicating that they hunted pigs (Table 1). Fifty-six percent of the hunters were successful with an average take of 2.6 pigs each during the season. The estimated total legal pig harvest was 389, a figure much higher than in FY 1981 (AWR 1981). An estimated 266 pig hunters spent an average of 8.8 eight-hour days hunting pigs.

Table 1. Island-wide pig hunting statistics for FY 1982.

a.	Total license sales for all game species	358
b.	Number of hunter report cards returned	43
c.	Percent of hunter report cards returned	12.0%
d.	Number of reporting hunters who hunted pigs	32
e.	Percent of reporting hunters who hunted pigs	74.4%
f.	Number of successful pig hunters	18
g.	Percent of reporting pig hunters who took pigs ($f \div d$)	56.3%
h.	Number of pigs taken by 32 hunters	47
i.	Average number of pigs taken per successful pig hunter ($h \div f$)	2.6
j.	Estimated total number of legal pig hunters ($a \times e$)	266
k.	Estimated total legal pig take ($g \times i \times j$)	389
l.	Number of 8-hour hunter days expended by 25 reporting pig hunters	219.6
m.	Average number of 8-hour days spent hunting per reporting pig hunter ($l \div 25$)	8.8
n.	Estimated total number of pig hunter days ($j \times m$)	2341
o.	Number of pig hunter days per pig taken ($n \div k$)	6.0

Nearly all hunters who returned their report cards indicated that they had hunted on either NWF or NCS, making these military lands the most popular areas for pig hunting (Table 2). Hunter logs were maintained at each military installation and hunters were required to sign in and out and report any game taken. The combined number of sorties made by gun and bow hunters were similar for both bases (Table 3). The number of pigs harvested rose sharply on both bases with 59 pigs taken at NWF and 31 at NCS. Of non-military lands, the Anao Conservation Area had the greatest reported number of pig hunters (Table 2).

In spotlight counts for deer at Naval Magazine (NAVMAG) and Andersen Air Force Base, only one pig was observed at NAVMAG. Because of behavioral characteristics of pigs and the dense nature of their preferred habitat, spotlight counts are not a good means of assessing numbers and other methods must be developed. Because of manpower shortages, no effort was made to determine the size of the pig population in the Bolanos Conservation Area or in other interior areas where access is limited.

Table 2. Island-wide distribution of pig hunting pressure based upon report cards returned by 25 hunters, FY 1982.

Hunting Locations	Number of Hunters	Number of Hunter Hours	Number of Pigs Taken
NWF	16	1019	21
NCS	11	498	13
Anao	3	110	1
Inarajan	1	40	2
Tarzan	2	36	0
Bolanos	1	16	0
Nav Fac	1	4	0
Others	3	34	1

Table 3. Hunter effort and pig take based on official hunter logs from NCS and NWF, FY 1982.

	NCS				NWF			
	#Gun Sorties	#Bow Sorties	Pig Take		#Gun Sorties	#Bow Sorties	Pig Take	
			Gun	Bow			Gun	Bow
October	353	19	9	-	392	5	23	-
November	236	36	12	-	324	1	20	-
December	244	40	9	1	202	0	16	-
TOTAL	833		31		924		59	
Total Hunter-Hours	3166				3459			
Total Hunter-Days	396				432			

RECOMMENDATIONS

Continue to monitor hunting seasons and the harvest of pigs. As manpower becomes available, increase management and research activities, particularly in the southern non-military areas.

LITERATURE CITED

Aquatic and Wildlife Resources Division. 1981. Job Progress Report - Federal Aid to Fish and Wildlife Restoration, Guam Dept. of Agriculture.

Report prepared by: Gary J. Wiles

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-19

SUB-PROJECT NO.: W-2

STUDY NO.: 1

JOB NO.: 1

JOB TITLE: Preparation of a Status Report on Phillipine Turtle Doves

PERIOD COVERED: October 1, 1981 to September 30, 1982

OBJECTIVES

To prepare a status report on Philippine turtle doves for use in planning future work.

RESULTS

This job was inactive during this segment due to the shortage of staff.

RECOMMENDATIONS

This job should be implemented in Segment 20 if adequate manpower is available.

Report prepared by: Robert D. Anderson

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-R-19
SUB-PROJECT NO.: W-2
STUDY NO.: 1
JOB NO.: 2

JOB TITLE: Population Numbers and Distribution of Philippine Turtle Doves

PERIOD COVERED: October 1, 1981 to September 30, 1982

SUMMARY

Roadside counts indicated that the Northwest Field (NWF) area had the highest Philippine turtle dove population of three areas censused, followed by the north-central and the north route. The counts on the north and north-central routes significantly ($P < .05$) decreased from the previous year.

BACKGROUND

Until recently, the Philippine turtle dove (Streptopelia bitorquata) was the only game bird on Guam. It was introduced by the Spanish about 1771 from the Philippines (Baker, 1951). The Philippine turtle dove has been a regulated game bird since the first hunting season was established in 1965. The current hunting season is July 1 to July 31, with a daily limit of four birds and a season limit of twenty. Although considerable work has been done in the past on nesting and movement of Philippine turtles doves (Drahos, 1977) current effort is restricted to roadside counts and monitoring of hunter harvest.

OBJECTIVE

To determine present population levels and distribution and monitor trends.

PROCEDURES

Bi-weekly roadside counts were made in three locations along paved and unpaved roads in northern Guam (see Figure 1, Job W-4-1-3 report). Each route was surveyed at sunrise by driving a jeep at 72 km per hour. The number and species of all birds observed were recorded. In order to monitor the annual hunter harvest during the legal season, hunters were required to submit hunter report cards to the Division of Aquatic and Wildlife Resources at the end of the year. Information from the report cards were used to estimate the number of Philippine turtle doves harvested during the season.

RESULTS

Roadside count data from FY 1981 and FY 1982 were compared using the Mann Whitney U-Test. Results of the roadside counts and the U-Test analysis are presented in Tables 1-4 of the Job W-4-1-3 report. The highest number of Philippine turtle doves observed, 140.2 birds/100km of travel, was recorded in Northwest Field. North and north-central routes recorded significantly ($P < .05$) fewer Philippine turtle doves than last year. Figure 1 graphically compares the roadside count results on all three routes since 1976.

The 1981 Philippine turtle dove hunting season was 1 July through 31 July, with a daily limit of four and a season limit of twenty birds. The results of the hunter report card survey of 1980 and 1981 are presented in Table 1. An increase of 8% more licenses were sold for the 1982 season. The estimated number of Philippine turtle dove hunters was 33, with an estimated total harvest of 340. This figure is subject to much bias because of the low report card return rate and the fact that successful hunters are most likely to return their cards.

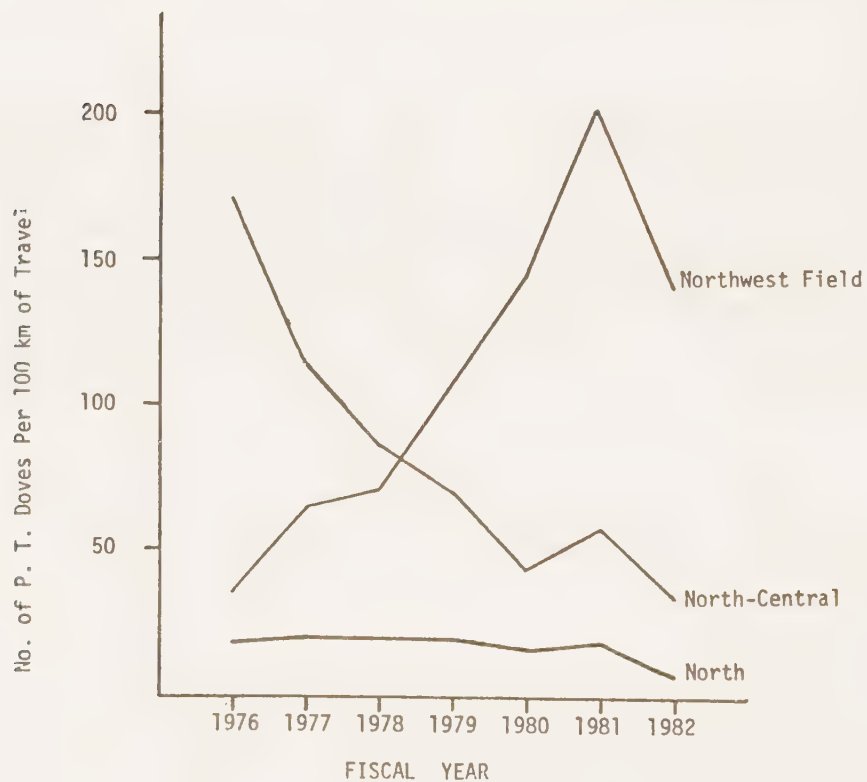


Figure 1. Mean number of P.T. Doves observed per 100 km of travel.

Table 1. Island-wide Philippine turtle dove hunting statistics, July 1980 and 1981.

	JULY 1980	JULY 1981
a. License sales	333	358
b. No. hunter report cards returned and properly filled out	35	43
c. Percent returned ($b \div a \times 100$)	10.5%	12.0%
d. No. reporting hunters who hunted doves	5	4
e. Percent of reporting hunters who hunted doves ($d \div b \times 100$)	14.3%	9.3%
f. No. successful dove hunters	4	4
g. Percent reporting dove hunters who took doves ($f \div d \times 100$)	80%	100.0%
h. No. doves taken by hunters	57	41
i. Average No. doves per successful hunter ($h \div f$)	14.3	10.3
j. Estimated total No. legal dove hunters ($a \times e$)	48	33
k. Estimated total No. legal doves taken ($j \times i$)	684	340
l. No. 8 hr. days expended by reporting dove hunters	15	8
m. Average No. days each hunter spent	2.5	2
n. Estimated total No. dove hunter days ($j \times m$)	120	66
o. No. dove hunter days per dove taken ($n \div k$)	.18	.19

RECOMMENDATIONS

1. Continue bi-weekly roadside counts in three locations in northern Guam and begin additional roadside counts or call counts in other areas to monitor distribution and relative abundance of Philippine turtle doves.
2. Continue to monitor hunter harvest and adjust hunting seasons and bag limits to provide for sustained yield management of dove populations.

LITERATURE CITED

- Baker, R. H. 1951. The avifauna of Micronesia, its origin evolution, and distribution. University of Kansas Pub. 3(1):1-359.
- Drahos, N. 1977. The Doves of Guam. Unpublished manuscript. Division of Aquatic and Wildlife Resources.

Report prepared by: Celestino F. Aguon

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-19

SUB PROJECT NO.: W-2

STUDY NO.: 2

JOB NO.: 2

JOB TITLE: Population Size and Distribution of Black Francolin on Guam

PERIOD COVERED: October 1, 1981 to September 30, 1982

SUMMARY

Results from monthly surveys conducted along three transect routes in southern savannah habitat on Guam indicated that the black francolin population increased quite rapidly and that the francolin population can now withstand an annual hunting season.

BACKGROUND

In April 1961, 171 black francolin were introduced in southern Guam as part of the Foreign Game Bird Introduction Program of the U.S. Fish and Wildlife Service. Surveys conducted during April through June 1980, in southern Guam, revealed that black francolin populations were established in most parts of southern Guam (DAWR 1980). Subsequent bimonthly surveys, during fiscal year 1982, were conducted along three of the nine established routes to monitor population trends.

OBJECTIVES

To determine current relative abundance of black francolin on Guam and ascertain the feasibility of establishing an annual black francolin hunting season.

PROCEDURES

Monthly surveys were conducted along three transect routes in southern Guam (Figure 1.). Stations were established along each transect and censused during the first four hours of daylight for five minutes based on the variable circular plot method (Reynolds et.al. 1980). All black francolin observed, visual or audio, within 180 m of the observer were recorded. Density estimated (D) were derived by the following:

$$D = \frac{2 \text{ (Highest monthly mean number of calling males per station)}}{DA}$$

where DA is the average detection area. The average detection area (DA) was empirically determined through field observation as 10.5 ha.

Figure 1. Black transect routes in southern Guam.



Assuming that the three transect routes were representative of most areas in southern Guam, the total black francolin population size was estimated by extrapolation. The average density of the three areas surveyed was multiplied by the total area (in hectares) of savannah habitat in southern Guam (DAWR 1980).

RESULTS

The average density of black francolin in southern Guam was 0.54 birds/ha (Table 1), yielding an extrapolated population estimate of approximately 7400 birds over the 13,700 ha of savannah in southern Guam (DAWR 1980). The mean number of calling males per station increased significantly ($P < .02$) in the Pulantat, Talofofo and Merizo areas from 1981 to 1982 (1982 data - Table 2; 1981 data - see DAWR 1981: 122). It is assumed that the number and density of calling males is a good indicator of population trends. If so, 1982 counts of calling males represents an increase in the francolin population of 30 to 90% for the three areas over the year.

Table 1. Estimated densities of black francolin (bird/ha) for fiscal years 1980-82 in three areas of southern Guam.

AREA	FISCAL YEAR		
	1980	1981	1982
Pulantat	0.31	0.34	0.57
Talofofo	0.36	0.35	0.66
Merizo	0.33	0.29	0.38
$\bar{X}$ all areas	0.33	0.33	0.54

Pulantat had the highest mean number of calling males in April, Talofofo in September, and Merizo in February (Table 2). It is assumed that male calling activity is somewhat indicative of breeding activity. No sharply defined breeding season is evident in the activity of calling males, however all three transects recorded high calling activity during January through August (Table 2). A lull in calling activity appears to occur from October to December (Table 3), similar to the trend noted in 1981 (DAWR 1981). Bump and Bump (1964) reported a much shorter breeding period of March to October for the francolin in India.

Three year trends in francolin populations (1980-82) were not consistent from area to area. Densities in the Pulantat area increased in 1981 and 1982, whereas densities in Talofofo and Merizo decreased in 1981 but increased in 1982 (Table 1). As stated above, all three areas had sizeable increases in 1982. Longer term census information will reveal whether the dramatic increases in 1982 were triggered by favorable environmental factors or that the population is still expanding in the post-release phase.

Table 2. Mean number of calling males per station recorded during monthly surveys during FY 1982 in three areas of southern Guam using fixed distance circular plots. The FY 1982 calling activity increased significantly ($P < 0.02$) in all three areas over the FY 1981 survey results as determined by a Mann-Whitney U-test (1981 data, see DAWR 1981:122).

Year										1981										1982									
Area		Month		OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Annual $\bar{X}$	SD	CV	pa*										
Pulantat				1.90	1.56	1.90	1.90	2.70	2.20	3.0	2.90	2.30	2.20	-	2.80	2.31	0.48	20.83	P<.002										
Talofofo				0.67	1.72	1.72	-	2.78	1.50	2.11	1.78	2.61	3.47	3.29	3.35	2.29	0.90	39.47	P<.002										
Merizo				0.0	1.75	1.17	1.50	2.00	1.82	1.91	1.09	1.73	1.36	1.45	0.55	1.36	0.59	43.50	P<.02										

* Probability determined by Mann-Whitney U-test (Sokal and Rohlf 1969)

Table 3. Mean numbers of calling males per station per recorded on surveys during FY 1981 and FY 1982 in three areas of southern Guam.

AREA	Pulantat						Talofofo						Merizo			
	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep
$\bar{X}$ calling males per station 1982	1.79	2.27	2.73	2.5	1.37	2.14	2.17	3.38	0.97	1.77	1.58	1.12				
$\bar{X}$ calling males per station 1981	.23	1.52	1.08	1.2	0.76	0.95	1.44	0.63	.48	1.23	0.99	0.62				

The estimated population of black francolin on Guam approaches 7400 birds, an increase of 55% in two years. The black francolin has now established itself in southern Guam and represents a successful introduction program. The population appears to be healthy and able to withstand an annual hunting season.

RECOMMENDATIONS

1. Continue monthly survey of black francolin along 3 transect routes.
2. Open the black francolin hunting season.
3. Collect and compile data on age and sex ratios from birds examined during spot checks of hunters throughout the 1982 black francolin hunting season.
4. Make an intensive post hunting season survey, preferably of the same transects established in 1980, to determine the impact of hunting pressure.
5. Make monthly collections of both sexes to collect data on reproductive status, age ratios, and food habits.

LITERATURE CITED

- Bump, G. and J.W. Bump. 1964. A study and review of the black francolin gray francolin. U.S. Fish and Wildlife Service, Washington, D.C. Special Scientific Report-Wildlife No. 81.
- Division of Aquatic and Wildlife Resources Annual Reports, Fiscal Years 1980-1981. Department of Agriculture, Government of Guam.
- Reynolds, R.T., J.M. Scott and R.A. Nussbaum. 1980. A variable circular plot-method for estimating bird numbers. Condor 82:309-313.
- Sokal, R.R. and F.J. Rohlf. 1969. Biometry. W.H. Freeman Company, San Francisco. 776p.

Report prepared by: Celestino F. Aguon and Paul Conry

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-19

SUB-PROJECT NO.: W-4

STUDY NO.: 1

JOB NO.: 3

JOB TITLE: Survey and Inventory of Native Land Birds on Guam and Northern
Marianas Islands

PERIOD COVERED: October 1, 1981 to September 30, 1982

SUMMARY

Results of roadside count data indicated a continual decline of Guam's native forest birds. Of the 12 native birds of Guam presently proposed for the inclusion on the U.S. Endangered Species List, six species have recorded significant ($P < 0.5$) declines in population. The Bridled White-eye, Vanikoro Swiftlet and Guam Broadbill remained undetected in roadside counts.

A re-analysis of station count data indicated a mean extirpation rate of approximately 2 species lost per year per area. Transect data showed a mean lost of approximately 1.5 species per year per area. In addition, susceptibility values were calculated for each species. The Bridled White-eye is the least abundant and presumably the most vulnerable of our native birds.

BACKGROUND

The native forest bird populations have been declining since the mid-1960's. Factors which have been cited as possible causes of this decline are: predators, eg., the Philippine rat snake (Boiga irregularis), three species of rats (Rattus sp.) and the monitor lizard, (Varanus indicus), pesticides, loss of habitat, and disease. Native forest birds are now restricted primarily to the northern cliffline limestone forest and some species (the Bridled White-eye) are found only in the forested area east of Ritidian Point.

Roadside and variable circular-plot censuses have been invaluable in providing a quantitative means of showing the alarming precipitous decline of Guam's native forest birds. Roadside counts have been conducted since the early 1960's over 3 routes in central to northern Guam. Density estimates of native forest bird populations derived from variable-circular plot censuses were conducted from 1979 to 1981. Similar censuses on Rota were conducted 4 times since 1979 and have provided a basis for comparison.

From June to July of 1981, an intensive forest bird survey utilizing variable-circular plots along randomly located transects was conducted by the U.S. Fish and Wildlife Service with the cooperation of this Division. A

complete and detailed report is still pending. In addition, the USFWS surveyed Rota, Tinian, Saipan, and Aguijan from March to June of 1982.

OBJECTIVES

To monitor population trends of the native land birds on Guam and the Northern Mariana Islands.

PROCEDURES

1. Roadside counts were conducted at bi-weekly intervals on three routes in northern Guam (Figure 1). These routes were driven at approximately 6-9 Km per hour beginning at sunrise. Numbers and species of all birds seen or heard were recorded, irrespective of the distance from the observer.
2. From February to June 1982, Division personnel and a volunteer surveyed 19 of the original 23 variable circular plot transects established in June, 1981 (Figure 2). Prior to censusing, personnel received additional training in distance estimation and species identification to ensure comparable data collection. The transects were randomly located to prevent bias and stations were premarked and placed 150m apart along the transects to minimize the possibility of observing the same bird from different stations. Stations were censused using eight minute variable circular-plot counts as described by Reynolds et. al. (1980).
3. Station counts conducted from October 1978 to September 1981 were discontinued in favor of transects. However, the station count data from these years was reanalysed to derive a mean extirpation rate (the mean number of species lost per year per area) and a Susceptibility Index for our native bird species. The mean extirpation rate, "R", for all stations for all bird species was calculated by the following:

$$\bar{R} = \frac{n}{x=1} \frac{S_i - S_f}{i_x - f_x} \times \frac{1}{n} \quad \text{where}$$

S_i : The number of species recorded during the initial year "i".

S_f : The number of species recorded in the final year "f".

n : Total no. of areas.

To determine the relative vulnerability of the native forest bird species susceptibility indices, "SI", were calculated by finding

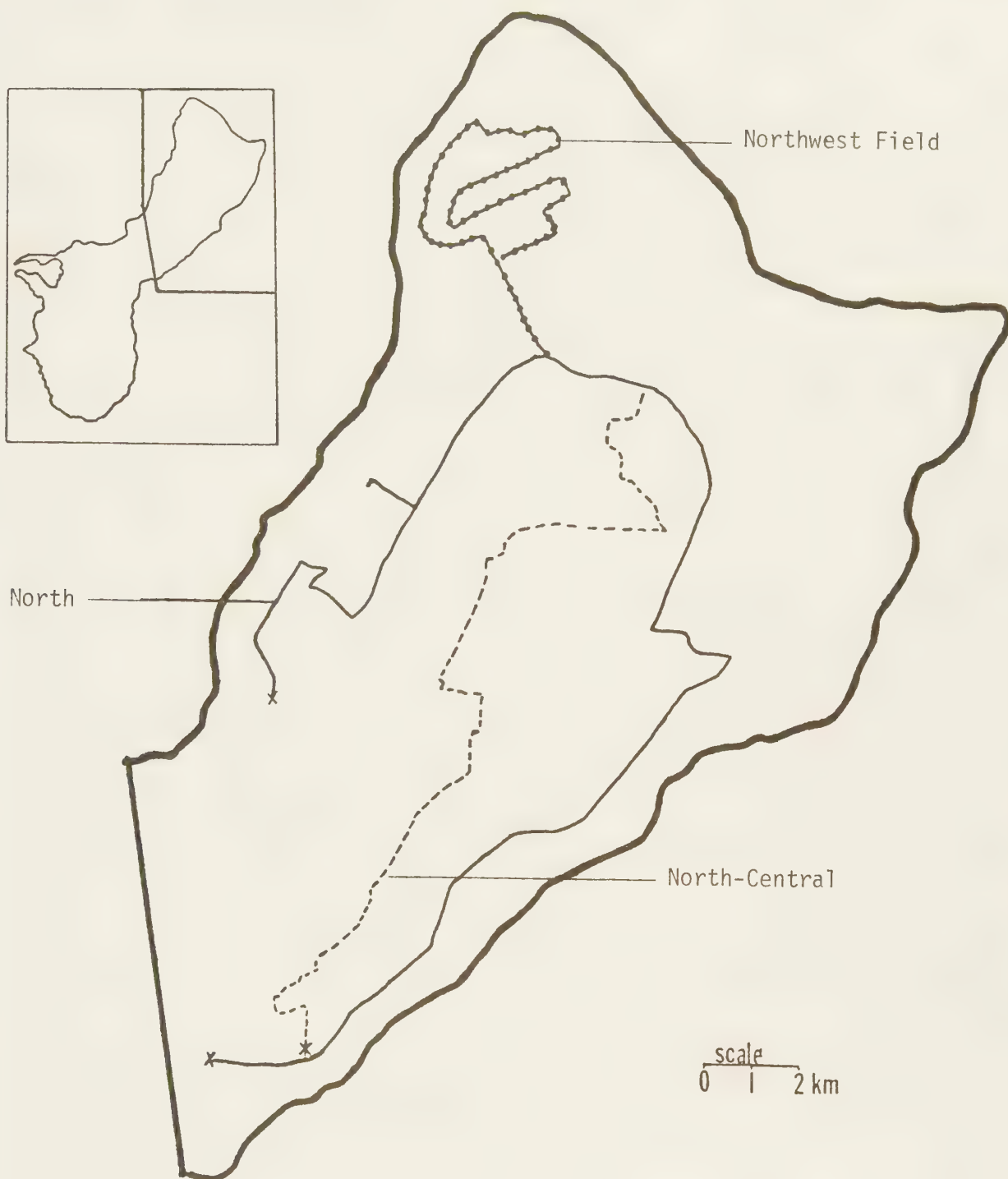


Figure 1. North, North-Central and Northwest Field roadside bird census routes along paved and unpaved roads.

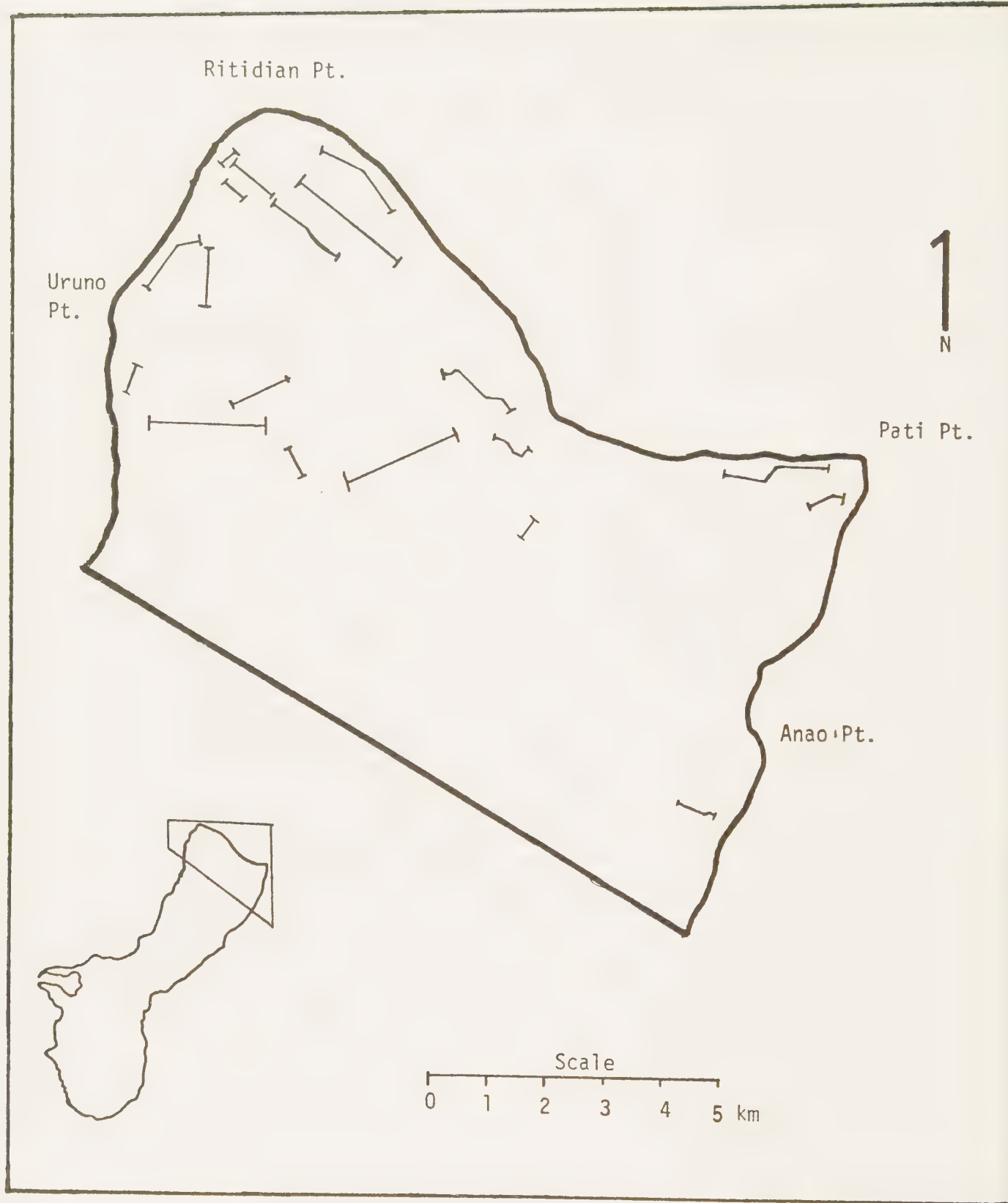


Figure 2. Location of the 19 random transects surveyed from February to June, 1982.

the sum of the number of areas for all years a species was observed at least once, i.e.:

$$SI = \sum_{x=1}^n A_x \quad \text{where,} \quad A_x = \begin{array}{l} \text{No. of areas in which a} \\ \text{particular species was} \\ \text{observed for a given} \\ \text{year "X"}. \end{array}$$

$n = \text{Total no. of years.}$

In addition, relative abundance (relative to the number of areas in which a species was found) were calculated for each species.

$$\text{Relative Abundance} = \frac{\text{SI of a species}}{\text{Sum of SI for all species}}$$

RESULTS

Roadside Counts

Results of the roadside counts on the north, north central, and Northwest Field routes are shown in Tables 1, 2, and 3, respectively. These results are summarized and statistically compared with 1981 data in Table 4. Significant declines ($P < .05$) in five species were found on the north central route and three species on the north route. No significant declines were noted in any species in Northwest Field. Northwest Field contained the greatest number of native forest bird species and the highest overall populations of the three roadside count areas. Although Northwest Field had the highest apparent populations of native birds, 44% of the native bird species present had counts of fewer than 10 birds per 100 km of travel, and only the Micronesian Starling had a value greater than 50 birds per 100 km of travel.

The only species registering significant increase ($P < .05$) in the roadside counts were the Marianas Fruit Dove in the Northwest Field and the Guam Rail on the north route in both cases, however, apparent populations levels are critically low and the indicated increases may be sampling artifacts.

In general, the roadside counts documented a long-term decline of most native birds. This is shown in Table 5, which summarizes roadside count data since 1976. As shown in Table 5, Northwest Field has consistently had the highest population of the three roadside count areas.

Transect and Station Count Survey

Computer analysis of data collected from the 1982 native forest bird transects has not been completed and consequently, complete analysis of data will be included into the 1983 Fiscal Year Annual Report. However, reanalysis of station count data and preliminary analysis of transect data has revealed alarming information concerning Guam's native avifauna.

Table 1. Number of birds per 100 Km observed each month on the North roadside count during Fiscal Year 1982.
No data was collected during April of 1982.

SPECIES	FY 1981												FY 1982				TOTAL	X/COUNT	X/100 km
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT							
Yellow Bittern	0.0	3.5	0.0	5.1	2.6	1.4	-	7.6	2.5	7.7	1.2	2.5	27	1.3				1.3	3.1
Martins Crow	0.0	0.0	1.3	0.0	2.6	0.0	-	0.0	0.0	0.0	0.0	0.0	3	0.1				0.1	0.4
Black Drong	47.7	5.3	35.0	22.9	8.9	16.9	-	17.7	0.1	20.6	13.9	35.4	175	8.3				8.3	20.2
Rufous-fronted Fantail	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	0	0.0				0.0	0.0
Martians Fruit Dove	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	0	0.0				0.0	0.0
Golden Plover	106.0	201.8	103.8	134.9	112.2	181.7	-	0.0	0.0	0.0	0.0	94.7	669	31.9				31.9	85.0
White-throated Ground-Dove	0.0	0.0	0.0	0.0	0.0	1.4	-	0.0	0.0	0.0	2.5	0.0	3	0.1				0.1	0.4
Cardinal Honeyeater	0.0	0.0	0.0	0.0	1.3	0.0	-	0.0	0.0	0.0	0.0	0.0	1	0.1				0.1	0.1
Micronesian Kingfisher	0.0	0.0	1.3	1.3	0.0	0.0	-	0.0	2.5	0.0	1.3	1.3	5	0.2				0.2	0.7
Noddy Tern	0.0	0.0	0.0	7.6	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	6	0.3				0.3	0.7
Philippine Turtle Dove	11.9	17.7	20.2	0.0	6.4	5.6	-	0.0	0.0	16.7	12.6	0.0	72	3.4				3.4	8.3
Chinese Painted Quail	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	17.7	14	0.7				0.7	1.6
Guam Rail	0.0	0.0	2.7	0.0	0.0	0.0	-	1.3	0.0	1.3	0.0	0.0	4	0.2				0.2	0.5
Chestnut Mannikin	4.0	0.0	0.0	6.4	0.0	0.0	-	0.0	0.0	7.7	6.3	0.0	19	0.9				0.9	2.2
Eurasian Tree Sparrow	18.5	17.7	0.0	2.5	16.6	0.0	-	12.7	7.6	0.0	35.3	17.7	94	4.5				4.5	11.7
Micronesian Starling	4.0	1.8	0.0	2.5	0.0	0.0	-	0.0	0.0	0.0	1.3	1.3	8	0.4				0.4	1.0
White Tern	1.3	0.0	0.0	0.0	0.0	1.4	-	1.3	0.0	0.0	0.0	0.0	3	0.1				0.1	3.4
Counts	2	2	2	2	2	2	-	2	1	2	2	2	21						

Table 2. Number of birds per 100 Km observed each month on the North-Central roadside count during Fiscal Year 1982.
No data was collected during June of 1982.

SPECIES	FY 19 81												FY 19 82				TOTAL	X/COUNT	X/100 km
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT							
Yellow Bittern	2.5	2.6	7.7	7.7	0.0	0.0	0.0	10.2	-	7.6	15.0	2.6	22	1.0				1.0	5.1
Marianas Crow	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0	0.0				0.0	0.0
Black Drongo	37.2	65.3	64.4	46.2	79.9	32.8	0.5	22.9	-	10.2	47.6	23.4	169	9.1				9.1	39.1
Rufous-fronted Fantail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0	0.0				0.0	0.0
Marianas Fruit Dove	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0	0.0				0.0	0.0
Golden Plover	456.6	1470.0	1314.4	748.2	525.8	954.5	235.9	7.6	-	0.0	0.0	316.9	2302	109.6				109.6	548.2
White-throated Ground-Dove	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	2.5	0.0	0.0	1	0.05				0.05	0.2
Cardinal Honeyeater	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	1	0.05				0.05	0.2
Micronesian Kingfisher	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0	0.0				0.0	0.0
Noddy Tern	42.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	17	0.8				0.8	3.8
Philippine Turtle Dove	0.0	49.6	43.8	20.5	49.0	53.0	25.6	38.2	-	15.3	35.1	41.6	140	6.7				6.7	33.8
Chinese Painted Quail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0	0.0				0.0	0.0
Guam Rail	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	-	0.0	0.0	0.0	1	0.05				0.05	0.2
Chestnut Monnikin	0.0	0.0	0.0	115.4	0.0	37.9	0.0	0.0	-	0.0	12.5	0.0	65	3.1				3.1	15.1
Eurasian Tree Sparrow	22.3	39.2	85.1	23.1	12.9	0.0	0.0	20.4	-	40.7	7.5	5.2	100	4.8				4.8	23.3
Micronesian Starling	0.0	0.0	0.0	0.0	0.0	25.3	0.0	0.0	-	0.0	2.5	0.0	11	0.5				0.5	2.5
White Tern	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0	0.0				0.0	0.0
Counts	2	2	2	2	2	2	1	2	-	2	2	2	21						

Table 3. Number of birds per 100 Km observed each month on the Northwest Field roadside count during Fiscal Year 1982.
No data were collected during May, June and July of 1982.

SPECIES	FY 1981												FY 1982				X/100 km
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	TOTAL	X/COUNT			
Yellow Bittern	5.8	7.4	2.9	20.3	5.8	14.0	9.8	-	-	-	1.8	2.8	31	1.48			7.8
Marsh Wren	52.5	32.3	55.1	26.1	37.7	5.6	20.7	-	-	-	31.1	76.5	137	6.52			37.5
Black-brown	524.8	374.7	269.6	449.3	423.2	359.6	354.0	-	-	-	592.3	895.2	1818	86.6			471.4
Rufous-fronted Fantail	20.4	14.9	55.1	11.6	8.7	14.0	3.3	-	-	-	0.0	42.5	62	3.0			18.9
Marshes Fruit Dove	0.0	0.0	2.9	0.0	0.0	5.6	2.2	-	-	-	0.0	8.5	8	0.40			2.1
Golden Plover	14.6	32.3	17.4	31.9	8.7	14.0	14.2	-	-	-	25.6	62.3	92	4.4			24.6
White-throated Ground-Dove	0.0	0.0	0.0	0.0	0.0	0.0	4.4	-	-	-	1.8	2.8	6	0.3			1.0
Cardinal Honeyeater	26.2	17.4	46.4	14.5	5.8	14.0	18.5	-	-	-	3.7	48.2	80	3.8			21.6
Micronesian Kingfisher	8.7	14.9	14.5	11.6	23.2	8.4	6.5	-	-	-	3.7	22.7	45	2.1			12.7
Booby Tern	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	0.0	0.0	0	0.0			0.0
Philippine Turtle Dove	102.0	111.7	144.9	46.4	104.2	103.9	226.6	-	-	-	164.5	257.8	608	29.0			140.2
Chinese Painted Quail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	0.0	0.0	0	0.0			0.0
Guano Rail	0.0	5.0	0.0	0.0	2.9	2.8	2.2	-	-	-	0.0	2.8	7	.3			1.7
Chestnut Mannikin	0.0	0.0	0.0	144.9	0.0	22.5	8.7	-	-	-	11.0	5.7	74	3.5			21.4
Eurasian Tree Sparrow	0.0	0.0	40.6	0.0	29.0	0.0	24.0	-	-	-	1.8	0.0	47	2.2			10.6
Micronesian Starling	78.7	49.6	118.8	14.5	95.7	39.3	54.5	-	-	-	45.7	130.3	261	12.4			69.7
White Iorn	0.0	0.0	0.0	0.0	26.1	0.0	1.1	-	-	-	0.0	2.8	11	0.5			3.3
Comps	2	2	2	2	2	2	4				3	2	21				

Table 4. Results of Northwest Field, North, and North-Central showing the mean number of birds per 100 kilometers of travel, the standard deviation (σ) and the coefficient of variation (CV). Asterisks "*" indicate means significantly lower ($P < .05$) and plus "+" indicate means significantly ($P > .05$) higher from preceding year. Mann Whitney U-test was used to test for significance (Sokal and Rohlf 1969).

Species	Northwest Field FY 1982			North FY 1982			North-Central FY 1982		
	$\bar{X}/100 \text{ Km}$	σ	CV	$\bar{X}/100 \text{ Km}$	σ	CV	$\bar{X}/100 \text{ Km}$	σ	CV
Yellow Bittern	7.8	36.5	465.7	3.1	2.7	2.3	5.1	4.9	4.7
Marianas Crow	37.5	21.7	11.8	0.4*	0.8	2.0	0.0	0.0	0.0
Black Drongo	471.4	185.8	73.2	20.4*	14.2	9.9	39.1*	24.5	15.3
Rufous-fronted Fantail	18.9	18.3	17.6	0.0	0.0	0.0	0.0*	0.0	0.0
Marianas Fruit Dove	2.1+	3.1	4.4	0.0*	0.0	0.0	0.0	0.0	0.0
Golden Plover	24.6	16.4	11.0	85.0	74.8	65.9	548.2	519.1	419.6
White-throated Ground Dove	1.0	1.6	2.7	0.4	0.8	1.9	0.2	0.8	2.5
Cardinal Honeyeater	21.6	16.0	11.8	0.1*	0.4	1.3	0.2*	0.8	2.6
Micronesian Kingfisher	12.7	6.8	3.7	0.7	0.9	1.1	0.0*	0.0	0.0
Noddy Tern	0.0	0.0	0.0	0.7*	2.3	7.6	3.8+	12.7	42.2
Philippine Turtle Dove	140.2	66.7	31.7	8.3*	7.9	7.5	33.8+	16.6	8.2
Chinese Painted Quail	0.0	0.0	0.0	1.6+	5.3	17.7	0.0	0.0	0.0
Guam Rail	1.7	1.8	1.9	0.5+	0.9	0.5	0.2*	0.8	2.6
Chestnut Mannikin	21.4	46.9	102.7	2.2+	3.2	4.6	15.1	35.2	82.3
Eurasian Tree Sparrow	10.6	16.0	24.3	11.7	11.0	10.4	23.3	24.8	26.4
Micronesian Starling	69.7	38.8	10.0	1.0	1.3	1.8	2.5	7.6	22.8
White Tern	3.3	8.6	22.1	0.4	0.6	1.1	0.0	0.0	0.0

FY		1976	1977	1978	1979	1980	1981	1982
Marianas Crow	NWF	15.3	19.9	19.6	29.4	21.7	29.0	37.5
	N	1.1	1.0	0.4	1.0	0.7	0.4	0.4
	NC	0.4	1.4	0.5	0.4	0.0	0.0	0.0
Rufous-fronted Fantail	NWF	22.4	14.4	12.8	10.1	12.3	12.4	18.9
	N	5.8	2.0	0.7	1.6	0.1	0.0	0.0
	NC	18.9	7.1	1.2	4.0	1.1	1.7	0.0
Marianas Fruit Dove	NWF	4.0	7.6	2.0	1.1	4.5	0.6	2.1
	N	0.6	0.0	0.1	0.2	0.7	0.5	0.0
	NC	0.5	0.4	0.0	1.4	0.9	0.0	0.0
White-throated Ground Dove	NWF	15.5	21.4	5.0	2.3	5.3	3.1	1.0
	N	5.4	3.0	3.2	2.4	3.9	0.5	0.4
	NC	13.1	14.0	16.0	7.5	2.7	3.0	0.2
Cardinal Honeyeater	NWF	30.7	31.3	23.8	11.2	10.4	23.9	21.6
	N	4.7	1.4	0.5	0.9	0.8	0.2	0.1
	NC	16.7	3.7	0.9	0.7	0.0	1.2	0.2
Micronesian Kingfisher	NWF	7.3	10.6	9.8	6.2	12.9	3.4	12.7
	N	1.6	1.1	1.1	1.6	0.4	2.0	0.7
	NC	7.1	7.6	4.8	4.4	1.1	0.9	0.0
Guam Rail	NWF	4.0	2.3	2.6	5.6	6.0	1.4	1.7
	N	11.2	9.3	4.7	4.3	1.4	0.0	0.5
	NC	80.4	34.7	41.6	20.1	8.6	1.4	0.2
Micronesian Starling	NWF	80.4	97.5	92.4	87.1	117.5	79.5	69.7
	N	9.0	8.0	5.7	7.3	4.2	7.1	1.0
	NC	35.6	23.4	7.0	9.2	3.7	5.2	2.5

Table 5. The mean number of birds per 100 Km of travel along three roadside counts; "NWF = Northwest Field Route, N = North Route, NC = North-Central Route". Values for 1976-1981 were taken from DAWR (1979-81).

The mean extirpation rate derived from station count data showed that each area lost approximately 1.82 species per year per area (S.D = 0.93, CV = 51.11). Furthermore, a comparison of the number of species recorded in the 1982 survey with the 1981 survey data indicated a mean loss of 1.5 species per transect (S.D = 1.4, CV = 92.8). At a rate of about 2 species lost per year, an area with all 10 native forest bird species (excluding the Vanikoro Swiftlet, which is no longer found in the North, and the Yellow Bittern which is still distributed islandwide) would lose all the native species in 5 years. Because of this high rate of loss, drastic measures should be implemented immediately in order to save Guam's birds. The only remaining area which has all native species, except the Vanikoro Swiftlet, is the 150 hectare forested area below the cliffline between Ritidian Point and Pajon Point. The estimated distribution of our native birds coupled with the high loss rate makes this east Ritidian population extremely vulnerable. Furthermore, the high extirpation rate of nearly 2 species per year casts doubt upon the current reliability of population estimates based on data collected more than a year ago.

Of the native species that disappeared from areas surveyed, 67% were last observed during the wet season and 33% were last observed in the dry season. Whether there is some seasonality associated with the decline remains to be ascertained.

To indicate the relative vulnerability of each species, a susceptibility index (SI) was derived by summing the yearly frequencies of occurrence of each species in each transect area. Results shown in Table 6 indicate that the Bridled White-eye, Guam Rail, and Guam Broadbill are the least abundant (and presumably most vulnerable) of our native forest birds. Because the Bridled White-eye is now found only in east Ritidian, this area should be monitored very closely for significant changes in population densities. Transects in the adjacent west Ritidian area recorded Bridled White-eyes as recently as 1981; should the general trend continue, the east Ritidian area could conceivably lose the Bridled White-eye by 1984.

RECOMMENDATIONS

1. Continue bi-monthly roadside counts over the three routes in northern Guam.
2. Establish a working agreement with the Division F&G, CNMI to monitor the native forest birds of the Northern Mariana Islands for any trends in population decline or increase, for comparison with bird populations on Guam.
3. Implement additional studies designed to investigate the cause decline of the native forest bird populations on Guam with emphasis on predation and disease.
4. Investigate and implement immediately measures to save Guam's native avifauna including captive propagation, predator control, as well as continuing programs to educate the public on the present situation.

Table 6. Susceptibility indices "SI" and Relative Abundances (RA) for each native forest bird species derived from station and transect data, 1978-1982. The SI value is equal to the number areas in which a species was observed. The total number of areas surveyed is 47.

Chamorro Name	Species		SI	RA
		Common Name		
Nossa		Bridled White-eye	12	.05
Koko'		Guam Rail	14	.06
Chiguanguang		Guam Broadbill	18	.07
Chichirika		Rufous-fronted Fantail	20	.08
Egigi		Cardinal Honeyeater	20	.08
Totot		Marianas Fruit Dove	21	.09
Paluman Fache		White-throated Ground Dove	28	.12
Paluman Apaka				
Aga		Marianas Crow	35	.15
Sihek		Micronesian Kingfisher	36	.15
Sali		Micronesian Starling	37	.15



5. Continue to seek Endangered Species listing for 12 native birds under the Endangered Species Act of 1973.
6. Monitor the east Ritidian forested areas on a monthly basis.
7. Continue natural history and breeding biology studies of the native avifauna.

LITERATURE CITED

Division of Aquatic and Wildlife Resources Annual Report. 1976-80.
Department of Agriculture, Government of Guam.

Reynolds, R.T., J.M. Scott and R.A. Nussbaum. 1980. A variable
circular-plot method for censusing birds. Condor 82(3):309-314.

Sokal, R.R. and F.J. Rohlf. 1969. Biometry, W.H. Freeman and Co. San
Francisco. 776 pp.

Prepared by Celestino F. Aguon

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-19
SUB-PROJECT NO.: W-5
STUDY NO.: 1
JOB NO.: 2

JOB TITLE: The current status, distribution and natural history of Marianas fruit bats.

PERIOD COVERED: October 1, 1981 to September 30, 1982

SUMMARY

Guam's fruit bat population is currently estimated at 850 to 1,000 animals. Approximately 780 to 850 bats (including young) are found in a single colony at Pati Point on Andersen Air Force Base (AAFB). Of bats found at the Pati Point colony, 80% roosted in harems, 17% lived in a single predominantly male group and 3% roosted solitarily. An adult sex ratio of 37.5 males: 100 females was present in the colony. During July, August and September, a mean of 21% of the adult females possessed unweaned young. Two known incidents of illegal hunting of bats occurred on Guam during the year. In FY 1982, 10,793 frozen fruit bats were imported to Guam from other islands for human consumption, a decline of 63% since FY 1980.

BACKGROUND

The Marianas fruit bat (Pteropus mariannus mariannus) is endemic to the Mariana Islands and is now considered endangered on Guam. This species has been proposed for endangered status under the Endangered Species Act of 1973. The Marianas fruit bat, considered a delicacy among the indigenous people, has been under investigation by the Aquatic and Wildlife Resources Division (AWRD) of Guam since 1962 (AWRD 1964-1981). These investigations documented a steady decline in a population index throughout the 1960's (Perez 1972). Thereafter, annual surveys revealed that only a few dispersed, solitary bats remained in the prime habitat on Guam which once supported colonies containing hundreds of bats (Wheeler and Aguon 1978, Wheeler 1979). Reasons for the decline included: increased human population pressures that resulted in over-hunting and permanent habit destruction, commercial exploitation of this food species, periodic severe typhoons, the lack of an adequate enforcement staff, and delays by the local legislature in passing protective legislation (Wheeler 1979). Fruit bats finally received full legal protection in 1973 and in 1981, they were placed on Guam's territorial Endangered Species List. Fruit bat abundance began to increase in 1980 and by 1981, Guam's population had grown to an estimated 650 to 750 animals.

OBJECTIVES

To monitor the current status and distribution of Marianas fruit bat populations in the Marianas Islands.

PROCEDURES

1. Continue the systematic survey of fruit bat distribution and numbers initiated on Guam in 1978 and on Saipan, Tinian and Rota in 1979.
 - a. Conduct annual surveys of Guam's northern cliffline with periodic surveys in other areas.
 1. Record bat numbers observed and search for additional bat colonies.
 2. For each bat observed record (where possible and applicable) flight elevation and direction, roosting tree species and height, part of plant eaten (flower fruit, seeds, leaves, etc.), height in forage tree, sex and age (if possible), other behavior such as vocalization, copulation, etc.
 - b. Conduct weekly intensive observations of major bat roosting colonies.
 - c. Conduct surveys on Rota, and other islands in the Northern Marianas as time and manpower permit.
2. Monitor fruit bat imports from the Northern Marianas and other island groups.
3. Maintain close liaison with other bat researchers and with government officials in other island groups as well as on Guam.

RESULTS

Bat Surveys on Guam

Monthly counts were conducted at Guam's only known fruit bat colony, located on the north side of Pati Point on Andersen Air Force Base. The number of bats (only adults were recorded) observed during counts ranged from 217 to 625 animals (Table 1). Although much variation occurred among counts, the actual number of bats in the roost probably remained fairly constant during the year. Low counts were caused when large portions of the colony changed to nearby roost trees which were out of view or that had thick foliage that hid most individuals. Several times when low counts were obtained, large numbers of bats were later frightened from their previously hidden roost sites, thus confirming that most of the colony was still present. Because there were always some bats hidden by thick foliage, the total number of adult bats in the colony was probably 10 to 20% higher than the actual number recorded during the highest count. In addition to the adults present, a mean of 21% of all adult females possessed young (see Natural History). These figures provide an estimate of 675 to 750 adults and 105 juveniles, or a total of 780 to 850 bats within the colony.

Table 1. Counts of visible Marianas fruit bats roosting at North Pati Point on Andersen Air Force Base in FY 1982.

Date	Number of Bats Observed
3 December	596
28 December	594
12 February	579
16 March	547
5 April	480
22 April	350
29 April	464
21 May	594
10 June	446
31 August	625
30 September	217

Small numbers of fruit bats were observed throughout the year during spot checks at Tarague Beach, Jinapsan Beach, Ritidian Point and Uruno Beach. These animals were solitary or congregated in small groups of 2 to 4 individuals and apparently never joined with the large roost at Pati Point. An estimated 50 to 100 bats inhabit this 17-km-long portion of northern Guam. In addition a small population of 25 to 50 animals live in the Naval Magazine and Talofofo region. Based on these figures, Guam's island-wide fruit bat population is estimated at 850 to 1,000 animals. These figures are slightly higher than the FY 1981 estimate of 650 to 750 bats (AWRD 1981). Although this may represent some actual population growth, much of the increase is more likely attributable to more accurate censusing techniques.

Bat Surveys in the Northern Marianas

No surveys of fruit bat abundance were conducted in the Northern Marianas Islands during FY 1982.

Bat Imports

Import permits are required for all shipments of fruit bats to Guam. There is currently no limit to the number of bats that can be requested on a single permit and retail merchants frequently inflate their requests to cover the possibility that a larger number of bats may be available at their supply source. During FY 1982, a total of 38,161 bats were requested for import (Table 2), a decline of 32% from the previous year and 65% from FY 1980 (AWRD 1980, 1981). Similarly, the number of frozen bats actually imported to Guam also dropped from former years. During FY 1982, 10,793 fruit bat carcasses in 136 shipments came to Guam from other islands (Table 3). This represents a decline of 63% since FY 1980, the last year in which import data is available (AWRD 1980). Guam's largest retailer of bats imported 39% of all animals brought to the island.

Palau continued as the largest supplier of fruit bats for the Guam market in FY 1982 (Table 3) with nearly 63% of all imported bats coming from that island group. Total imports from Palau, however, have dropped considerably since 1980. A ban on the use of all firearms, passed in early 1982 by the Palauan government, may have contributed indirectly to reducing fruit bat imports by limiting hunting. However, hunting with air-powered rifles or by traditional methods, such as slings or nets, is still legal there.

For the first time, Western Samoa was also a major exporter of bats to Guam. Since Samoan fruit bats (*P. samoensis*) are larger and are considered by local Chamorro people to taste better than bats (*P. pelewensis*) from Palau, Western Samoa will probably remain a principal source in the future.

Table 2. Numbers of frozen fruit bats requested for import to Guam between October 1, 1981 and September 30, 1982.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	No. of Permits Issued
Palau	917	3085	3180	1800	845	390	1755	1420	1160	605	1575	365	17097	155
Western Samoa		150	800	500		300		2600	1000		2000	1500	8850	21
American Samoa			50					2400	1000	30			3480	9
Truk	110	100	75	400	200	1000		650	350	200			3085	17
Tonga								400	1000			1000	2400	9
Rota	915	70	83										1068	37
Ponape		600	130	60	20	20	66		40	50		50	1036	14
Saipan	330	20	90	80	130								650	24
Philippines										200			200	1
Tinian	20			125									145	4
Kosrae			50										50	1
TOTAL	2292	4025	4458	2965	1195	1710	1821	7470	4550	1085	3575	2915	38161	292

Table 3. Numbers of frozen fruit bats imported to Guam between October 1, 1981 and September 30, 1982 based on import permits processed through Customs.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	No. of Imports Shipped
Palau	285	1765	1706	178	480	120	510	400	200	445	550	125	6764	71
Western Samoa	200		450	500					550	500	500		2700	12
Rota	201	90	61	7	7								366	31
Ponape			280			20	66						366	6
Truk			2						200	5			207	3
Philippines											200		200	1
Saipan	75		15	60									150	10
American Samoa	10									30			40	2
TOTAL	771	1855	2514	745	487	140	576	400	950	980	1250	125	10793	136

Imports of bats to Guam from the Northern Marianas fell dramatically in FY 1982, making up only 5% of the total, the lowest amount since records have been kept (AWRD 1975-1981). The main cause for this was the ratification of the Guam Endangered Species List by the 16th Guam Legislature on February 2, 1982. The Marianas fruit bat is classified as endangered under the Endangered Species Act of Guam (PL 15-36) and the importation of P. mariannus is now prohibited. Because correct identification of frozen fruit bats is difficult, virtually all subsequent shipments from Saipan of other bat species as well as P. mariannus have stopped. In the past, many of the bats shipped to Guam from Saipan were probably not P. mariannus but were instead species that had been previously imported to Saipan from the Carolines. These were then later purchased by Guamanians visiting Saipan.

One other factor in the decline of bat imports during FY 1982 may be attributable in part to the Division of Aquatic and Wildlife Resources nature education programs, portions of which were directed toward conservation of bats.

Natural History

Information on roosting behavior was collected throughout the year during observations of the fruit bat colony at North Pati Point. The information presented here is considered more refined than the preliminary data in FY 1981 and supercedes AWRD (1981).

Social Organization - As first noted in FY 1981 (AWRD 1981), bats within the colony occurred in sexually segregated groups. Throughout the year, about 80% of all individuals roosted in harems which contained a single dominant male and

two to 15 females ($\bar{X} = 8.9$, $n = 16$). Harem males maintained exclusive breeding rights with these females and only rarely tolerated the presence of another male. Generally, females appear to be loosely bound to a particular harem. The number of females present in a harem may vary considerably over a period of several days and even during single observation periods of a few hours, it was not usual to see several females arrive at or depart from a harem.

Depending on crown size, roost trees may contain one to as many as 15 closely adjoining harems. Aggressive interactions between neighboring harem males were never observed however, harem males always defended their territories against intruding bachelor males. On occasion, intruding females were also driven away by harem males.

A single large group of predominantly bachelor males made up approximately 17% of all bats in the colony. Sexual segregation within this group was not complete and about 10 to 20% of the individuals were females. The remaining 3% of the colony consisted primarily of solitary males found around the periphery of the roost.

Illegal hunting at roost sites where bats form harems may have an extreme effect in reducing the productivity of the colony. Large numbers of females are vulnerable to being killed in a single poaching incident under these conditions.

Sex Ratio - Estimates of adult sex ratios were obtained for harems, the large group of predominantly bachelor males, and for solitary individuals. In 16 harems, females comprised 89% of all bats present ($n=164$) while, in contrast, they made up only 8.5% of the individuals in the predominantly bachelor male group ($n=117$) and 5.7% of all solitary animals ($n=35$) (Table 4). Based on this information and on the proportion of each social grouping within the roost, a colony of 700 adult fruit bats would contain approximately 191 males and 509 females, a ratio of 37.5 males:100 females. Since young bats cling tightly to their mother's chest fur, it was not possible to identify the sex of any juveniles.

Table 4. Estimated number of males and females per social group in a colony of 700 Marianas fruit bats at North Pati Point, FY 1982.

Social Group	Proportion of Colony (%)	Estimated No. Of Individuals Present	% Observed		No. Estimated To Be Present		♂:♀ Ratio
			♂	♀	♂	♀	
harems	80	560	11.0	89.0	62	498	12:100
predominantly bachelor male group	17	119	91.6	8.04	109	10	1070:100
solitary bats	3	21	94.3	5.7	20	1	1650:100
Colony Total	100	700	27.3	72.7	191	509	37.5:100

Reproduction - Most species of Pteropus have a sharply defined breeding season (Baker and Baker 1936). In species found north of latitude 4°N, young are generally born in March and April while species found south of this latitude generally produce young in September and October. However, in Micronesia, this trend has not been substantiated. In Ponape, Jackson (1962) collected unweaned P. molossinus in February, September and November suggesting a prolonged breeding season for this species. Unweaned young of P. mariannus have been found throughout the year on Guam (Perez 1972). In this study, copulation and unweaned young were noted in every month of the year. Beginning in July, a minimum of 50 harem females were observed each month to determine whether they possessed unweaned young. During the three months, a mean of 21% of all females had young (Table 5). In July, 32.7% of all females possessed young while in September, this figure declined to 13.9%.

Table 5. Number of harem females observed with unweaned young at North Pati Point during July, August and September, FY 1982.

	No. of ♀ observed	No. of ♀ without young	No. of ♀ with small young	No. of ♀ with medium sized young	No. of ♀ with large young	% of ♀ with young
July	52	35	5	12	0	32.7
August	74	59	3	12	0	20.3
September	79	68	5	4	2	13.9
TOTAL	205	162	13	28	2	21.0

Illegal Hunting

Poaching probably continues to be the major factor slowing the recovery of Guam's fruit bat population. Two known incidents of illegal hunting of bats occurred in FY 1982. On 19 May at 1030 three poachers with two dead bats in their possession were arrested by Conservation Officers in the Conventional Weapons Area (CWA) on AAFB. On 12 June, a fruit bat which had been shot was found inside an unoccupied pickup truck trespassing on Naval Magazine. No poaching is known to have occurred at Pati Point colony this year (see Report W-5-1-3).

RECOMMENDATIONS

1. Survey bat numbers and distribution along Guam's entire northern cliffline once or twice annually.
2. Continue to make observations at the Pati Point colony. Information should be gathered on reproductive biology, behavior within the colony and the number of bats present.

3. Resume annual or twice-annual surveys of fruit bat abundance and colony locations on Rota. The remainder of the Northern Marianas Islands should be visited when possible in order to obtain an estimate of the entire population of fruit bats within the archipelago. Procedures for survey should follow those recommended by AWRD (1981).
4. Continue to monitor fruit bat imports entering Guam. Export permits or certificates of origin should continue to be required for all shipments to ensure that the bats have been legally harvested, that the place of origin is known, and that the government authorities at the place of origin are aware of the drain on their resources. Regulations prohibiting the trade of *P. mariannus* should be maintained until a reliable population estimate for all of the Marianas Islands has been obtained.

LITERATURE CITED

- Aquatic and Wildlife Resources Division. 1964-1981. Job Progress Reports - Federal Aid to Fish and Wildlife Restoration, Guam. Dept. of Agriculture, Government of Guam, Agana, Guam.
- Baker, J.R. and Z. Baker. 1936. The seasons of a tropical rain forest (New Hebrides) fruit bats (Pteropidae). J. Linn. Soc., Lond. 40: 123-141.
- Jackson, W.B. 1962. Area of study. Pp. 14-38 in T.I. Storer (Ed.). Pacific island rat ecology. B.P. Bishop Museum, Honolulu, Hawaii. 274 pp.
- Perez, G.S.A. 1972. Observation of Guam bats. Micronesica 8:141-149.
- Wheeler, M.E. 1979. The Marianas fruit bat: management history, current status and future plans. Proceedings of the 10th Annual Joint Conference of the Western Section, The Wildlife Society, and the California-Nevada Chapter, American Fisheries Society.
- Wheeler, M.E. and C.F. Aguon. 1978. The current status and distribution of the Marianas fruit bat on Guam. Aquatic and Wildlife Resources Division Technical Report No. 1. Dept. of Agriculture, Box 23367, GMF, Guam, M.I. 29 pp.

Report prepared by: Gary J. Wiles

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-19
SUB-PROJECT NO.: W-5
STUDY NO.: 1
JOB NO.: 3

JOB TITLE: Movement patterns and habitat utilization of Marianas fruit bats.

PERIOD COVERED: October 1, 1981 to September 30, 1982

JOB OBJECTIVES: To determine movement and activity patterns, home range size, and patterns of habitat utilization, with an emphasis upon roost site fidelity and inter-island migration.

SUMMARY

Observations at Guam's only known colony of Marianas fruit bats (Pteropus mariannus mariannus) provided data on roost site fidelity and roost tree preference. A single roost site was used by the colony during the year and has now been inhabited for 15 consecutive months. Mature Ficus sp., which are characterized by large, open crowns, were the favored roost trees at this colony. An experimental necklace made of stainless steel ball chain worked satisfactorily in marking a captive adult fruit bat.

BACKGROUND

Little is known about the movements of Marianas fruit bats on Guam. Low population levels and the tree-dwelling habits of bats have made capture attempts and banding studies impractical. In the past, most information has come from incidental sightings and reports from local citizens (Perez 1972). Knowledge of movements, particularly between islands, is necessary in formulating proper cooperative management measures for bats in Guam and the Commonwealth of the Northern Marianas.

PROCEDURES

1. Develop methods and techniques for capturing, marking and instrumenting fruit bats.
 - a. Acquire a limited number of live fruit bats for experimental purposes. Bats to be maintained in a facility to be constructed under W-2-D-2.
 1. Obtain necessary federal and local permits.
 - b. Develop and test marking, banding or tagging methods.

- c. Develop and test methods of instrumenting bats with radio-telemetry equipment.
2. Implement a bat banding or marking program.
3. Implement a telemetry study of bat movement and activity patterns. (to be developed)
 - a. Telemetry study to emphasize roost-site fidelity, activity patterns, inter-island migration, and habitat utilization.
 1. Habitat ordination through multi-variate analysis of telemetry and direct observational data.

RESULTS

This job was in the planning stage during this segment pending the development of an effective method of attaching radio transmitters to fruit bats. However, preliminary results pertaining to this job were obtained during other field activities (see Report W5-1-2).

Roost Site Fidelity

During FY 1982, Guam's single known colony of fruit bats roosted exclusively on the northern side of Pati Point on Andersen Air Force Base. This colony of about 800 animals has inhabited the site since 24 June, 1981, a total of 15 months. The relatively long tenure of this site probably indicates that little or no human disturbance has occurred since the bats began roosting here. Poaching incidents caused two of the three roost locations used in FY 1981 to be abandoned after brief stays (AWRD 1981). Other species of Pteropus, when undisturbed, have been reported to roost for many years at the same colony locations (Ratcliffe 1932, Neuweiler 1969).

Inter-Island Movement

No further information on this subject was gathered in FY 1982.

Terrain and Vegetation at Bat Roosts

During censuses of the North Pati Point colony, the identity of roost trees and the number of fruit bats present in each were determined. Ficus sp. were most preferred with 67.4% of all bats choosing to roost in this genus of tree (Table 1). Ficus are common in this portion of limestone forest and bats were seen using a mean of 8.6 trees per observation period, the most for any tree species. With their large, open crowns, mature Ficus can easily hold large numbers of bats. An average of 35.2 bats were counted in these trees while one individual tree, which was used consistently during the year by a large number of harems, normally contained 150 to 250 bats (maximum of 378).

Other tree species within the colony are either less abundant than Ficus or possess smaller crowns and denser branching patterns which offer fewer roosting sites. Mammea odorata is characterized by a tall, vertical crown with short branches and large, leathery leaves. Although this species was often used by roosting bats, relatively few animals (average of 6.1) were present in each tree (Table 1). Other species such as

Table 1. Use of roosting trees by fruit bats at North Pati Point on eight observation days from February to September, FY 1982.

Tree Species	Total No. of Bats Roosting per Tree Species	% of Bats Roosting per Tree Species	Ave. No. of Roost Trees Used per Day	Max. No. of Bats Roosting in a Single Tree per Day	Ave. No. of Bats Roosting per Tree
<u>Ficus</u> sp.	2426	67.4	8.6	378	35.2
<u>Macaranga thompsonii</u>	395	11.0	1.5	71	32.9
<u>Mammea odorata</u>	249	6.9	5.1	19	6.1
<u>Guetterda speciosa</u>	198	5.5	0.9	38	28.3
<u>Neisosperma oppositifolia</u>	166	4.6	1.0	36	20.8
<u>Bikkia mariannensis</u>	10	0.3	0.5	5	2.5
<u>Triphasia tripholia</u>	4	0.1	0.3	2	2.0
Unknown	151	4.2	1.6	28	11.6
TOTAL	3599	100.1	19.5	-	23.1

Macaranga thompsonii, Premna obtusifolia and Neisosperma oppositifolia were able to hold larger numbers of bats but were uncommon within the roost. Although not found on Pati Point, Casuarina equisetifolia is also a favored roost tree of fruit bats (Wheeler and Aguon 1978). Like Ficus, it also has an open crown which allows for easier take-offs and landings by bats.

Marking of Fruit Bats

An experimental necklace made of stainless steel ball chain was placed for eight weeks on an adult female fruit bat at the Cushing Zoo in Tumon, Guam. A 9.8-cm length (equivalent to 30 balls and one connecting piece) of #3 ball chain was used and fit moderately snugly around the bat's neck. Two 1A-sized aluminum bird bands with an inside diameter of 3.0 mm were placed on the chain to test their efficiency in providing additional identification. The necklace caused little irritation to the bat and no abnormal behavior was noted. Thus, it is recommended that this type of collar be placed on all fruit bats which are captured but not radio-tagged.

RECOMMENDATIONS

1. Finalize the acquisition of all radio telemetry equipment.
2. Determine the best method for attaching radio transmitters to fruit bats by experimentally placing dummy transmitters on the captive bats in the Cushing Zoo in Tumon, Guam.
3. Develop methods of capturing fruit bats. One potential method should be to search for fruiting trees in known feeding areas and attempt to capture visiting bats with mist nets.
4. Pattern telemetry studies after those of Heithaus and Fleming (1978) and Morrison (1978) to determine fidelity to day roosts, periods of activity, consistency in use of feeding areas, locations of feeding areas, foraging distances and behavior, food species, and inter-island movements.
5. Continue regular observations and counts at known fruit bat colonies.

LITERATURE CITED

- Aquatic and Wildlife Resources Division. 1981. Job Progress reports - Federal Aid to Fish and Wildlife Restoration, Guam, Dept. of Agriculture.
- Heithaus, E.R. and T.H. Fleming. 1978. Foraging movements of a frugivorous bat, Carollia perspicillata (Phyllostomatidae). Ecol. Monogr. 48:127-143.
- Morrison, D.W. 1978. Foraging ecology and energetics of the frugivorous bat Artibeus jamaicensis. Ecology 59:716-723.

- Neuweiler, G. 1969. Verhaltensbeobachtungen an einer indischen Flughundkolonie (Pteropus g. giganteus Brunn). Z. Tierpsychol. 26:166-199.
- Perez, G.S.A. 1972. Observations of Guam bats. Micronesica 8:141-149.
- Ratcliffe, F.N. 1932. Notes on the fruit bats (Pteropus sp.) of Australia. J. Anim. Ecol. 1:32-57.
- Wheeler, M.E. and C.F. Aguon. 1978. The current status and distribution of the Marianas fruit bat on Guam. Division of Aquatic and Wildlife Resources Technical Report No. 1. Department of Agriculture, Box 23367, GMF, Guam, M.I. 29 p.

Report prepared by Gary J. Wiles



JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-19

SUBPROJECT NO.: W-5

STUDY NO.: 1

JOB NO.: 5

JOB TITLE: Impact of Avian Disease on Guam's Native Bird Population

PERIOD COVERED: October 1, 1982 to September 30, 1982

OBJECTIVE

To determine the presence and impact of avian disease on Guam's bird populations.

PROCEDURES

1. Conduct a controlled study using caged canaries (Serinus canarius) in northern, central and southern Guam to determine presence of avian disease.

RESULTS

Study design has been completed in collaboration with the National Wildlife Health Laboratory. Project implementation was postponed due to lack of personnel.

RECOMMENDATIONS

Initially concentrate on existing sentinels such as poultry and captive pigeons before conducting experiments using caged canaries.

Report prepared by: Julie A. Savidge

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT: FW-2R-19
SUB-PROJECT NO.: W-5
STUDY NO.: 2
JOB NO.: 1

JOB TITLE: Preparation of a status report and species management plan for the native doves of Guam.

PERIOD COVERED: October 1, 1981 to September 30, 1982

PROCEDURES

1. Synthesize material from past reports and manuscripts and all available data.
2. Identify management and research needs and make recommendations for future work.

RESULTS

This job was inactive during this segment due to a shortage of staff.

RECOMMENDATIONS

Complete this job in Segment 20.

Report prepared by: Robert D. Anderson

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-19
SUB-PROJECT NO.: W-5
STUDY NO.: 3
JOB NO.: 2

JOB TITLE: Identification and Acquisition of Land Useful as Guam Rail
Habitat

Period Covered: October 1, 1981 to September 30, 1982

SUMMARY

Steps have been taken to acquire certain land areas that have value as habitat for Guam Rail.

BACKGROUND

As previously reported, the Guam rail has declined drastically in number and distribution, and is now restricted to the northern half of Guam. In order to prevent further decline rail has been recommended for endangered status, and most of its current range proposed as critical habitat. Some of the most valuable rail habitat is currently under military control. Some of these lands, however, have been identified as being excess to military needs and may become available for transfer to the Government of Guam. In order to safeguard these lands for the protection of the Guam rail and other native birds, the Division has been working closely with the Bureau of Planning in identifying the lands best suited as rail habitat and in preparing applications for acquisition of these lands.

OBJECTIVES

To set aside and protect valuable Guam rail habitat using existing legal authorities.

PROCEDURES

1. Identify and attempt to acquire land that provides habitat for the Guam rail.
2. Work closely with the Bureau of Planning in preparing applications for the transfer of excess military land to the Government of Guam.

RESULTS

The Division has recommended that a large of area of northern Guam be declared critical habitat for the protection of the Guam rail. This species is a candidate for endangered status under the Federal Endangered Species Act of 1973. Although rails were recommended for listing in 1978, bureaucratic and administrative procedures have precluded positive action to date. The major obstacle to overcome is the economic impact analysis now required for designation of critical habitat; hopefully the Fish and Wildlife Service will resolve this problem and action to list the Guam rail and protect its habitat on the Federal level will be taken in 1983.

The Division has worked closely with the Bureau of Planning to identify excess military land that has value as rail habitat and to prepare applications for the transfer of these lands to the Government of Guam. In excess of 1600 acres have been so identified. Draft applications have been prepared for most of these lands; as they become available, these applications will be finalized and submitted to the General Services Administration.

RECOMMENDATION

Continue with current requests for the acquisition of designated excess military land for protection of Guam rail habitat.

Report prepared by: Robert D. Anderson

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-19
SUB-PROJECT NO.: W-5
STUDY NO.: 5
JOB NO.: 1

JOB TITLE: Preparation of a Status Report and Species Management
Plan for the Vanikoro Swiftlet

PERIOD COVERED: October 1, 1981 to September 30, 1982

OBJECTIVES

To develop a status report and species management plan for the Vanikoro swiftlet.

RESULTS

This job was inactive during this segment due to shortage of staff.

RECOMMENDATIONS

This job should be implemented in Segment 20 if adequate manpower is available.

Report prepared by: Robert D. Anderson

GUAM ENDANGERED SPECIES INVESTIGATIONS
PROJECT E-1-1
Section 6 - Endangered Species Act of 1973

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E -1

STUDY NO.: 1

JOB NO.: 1

JOB TITLE: Impact of Environmental Contaminants on Native Forest Bird Populations.

PERIOD COVERED: October 1, 1981 to September 30, 1982

SUMMARY

A study of the impact of environmental contaminants on Guam's bird populations was conducted.

BACKGROUND

Populations of Guam's native birds have declined sharply in recent years, to the point that twelve species have now been recommended for endangered status. Pesticide contamination has been suggested as a possible cause of this decline, based partially upon the facts that DDT was heavily used on the island during and after World War and that DDT and DDE residues have been found in body tissues and guano of the Vanikoro swiftlet. This cave-dwelling insectivorous bird has declined from a population of thousands (3,000-4000 in 1966) to fewer than 200 today. This is currently one of the rarest birds on Guam.

Initial efforts to investigate the impact of pesticides upon Guam's wildlife were conducted under Job W-5-7-1 (FW-2R-18). That job concentrated upon historical review and recommended that technical assistance in developing and conducting detailed pesticide studies be obtained from the Patuxent Wildlife Research Center (PWRC). That job further recommended that the pesticide investigation effort be funded through the Division's Section 6 Endangered Species Cooperative Agreement with the U.S. Fish and Wildlife Service.

A cooperative study was developed with the Patuxent Wildlife Research Center and Dr. Christian Grue made an initial trip to Guam in March 1981. Dr. Grue prepared a detailed study plan and returned to Guam in late May to begin approximately six weeks of intensive field sampling.

OBJECTIVES

To design and implement an environmental contaminant research program that will determine the impact these substances have on Guam's native forest bird populations.

PROCEDURES

Procedures used and sampling design will be detailed in Dr. Grues final report.

In summary, Dr. Grue and a field assistant hired locally collected samples of soil, guano, earthworms, insects, snails, toads, lizards, shrews, and other organisms from a number of locations around Guam. All specimens were transported to the Patuxent Wildlife Resource Center where they were prepared for analysis. Chemical analysis was performed by PWRC and Hazleton-Raltech, Inc., a contract laboratory.

RESULTS

Analytical results have been received and a final report is currently being prepared by Dr. Grue. The final report is planned for publication in Pacific Science.

Dr. Grue's tentative conclusion is that pesticides do not currently appear to be a significant problem on Guam, although pesticide use may have had an impact on certain birds in the past. Dr. Grue suggested that other factors, such as disease, should be investigated as the cause of the decline in Guam's birds.

RECOMMENDATIONS

Dr. Grues strong recommendation is that avian disease be investigated as soon as possible as the most likely cause of the decline of Guam's native bird populations.

Report prepared by. Robert D. Anderson

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E -1
STUDY NO.: 1
JOB NO.: 2

JOB TITLE: Investigations into the Biology of the Monitor Lizard and the Philippine Rat Snake.

PERIOD COVERED: October 1, 1981 to September 30, 1982

SUMMARY

A preliminary review of literature on both reptiles was conducted. The stomach contents of 82 Philippine rat snakes and 20 monitor lizards were examined. In-depth studies remain to be implemented due to a lack of personnel.

BACKGROUND

The native birds of Guam evolved in a predator-free, insular environment. Over the past 200-300 years, predators such as dogs, cats, pigs, three species of rats, a shrew, monitor lizards and the Philippine rat snake have been accidentally or deliberately introduced to Guam and may now be having a significant impact on the dangerously low native bird populations.

The monitor lizard (Varanus indicus) and the Philippine rat snake (Boiga irregularis) have been known to take birds and bird's eggs on Guam and are considered efficient arboreal predators (Uchida 1966, Drahos 1977). Because Boiga is nocturnal (McCoy 1980) and arboreal, it could possibly be placing more pressure on Guam's native avifauna.

OBJECTIVES

To design and implement a study of the life history, feeding habits and activity patterns of the monitor lizard and the Philippine rat snake.

PROCEDURES

1. A preliminary review of literature from the Pacific Basin concerning these reptiles was accomplished using computer searches.
2. Snakes collected by the public and governmental agencies were examined for stomach contents; measurements and other pertinent information were also recorded.

Table 1. Stomach contents of 85 Philippine rat snakes examined by Division biologists from 1967 to 1982. "No." indicates the number of stomachs that contained a certain food item. " $\frac{\text{No.}}{100}$ " indicates the percentage of stomachs examined that contained a food item.

Year	1967		1980		1981		1982		Total	
Total No. of Snakes examined	1		22		16		46		85	
Stomach Contents	No.	%	No.	%	No.	%	No.	%	No.	%
Empty	1	100	7	33	10	63	39	85	56	66
Native bird			1	5	1	6			3	4
Domestic bird			3	14	1	6			4	5
Exotic bird			2	9					2	2
Egg			6	27	2	13	3	7	11	13
Small lizard			2	9					2	2
Kitten					1	6			1	1
Rat					1	6	1	2	2	2
Rabbit			1	5					1	1
Toad							1	2	1	1
Unknown							1	2	1	1

Table 2. Lengths of 105 Philippine rat snakes examined by biologists from 1963-82.

Year /	Size (cm)				
	< 50	< 100	< 150	< 200	< 250
1963	1		1		1
1964		3		1	1
1965		4		3	3
1966		2	1	1	1
1971		2			1
1980		3	1	10	7
1981	1	1	3	4	2
1982		8	11	19	9
Total	2	23	17	38	25

RESULTS

A total of 85 snake stomachs were examined from 1967 to 1982 of which 56 (66%) were empty and 29 (34%) contained prey items. Eggs and birds were the most common prey items found. The high percentage of items associated with urban areas (only three native birds found) is reflected by the fact that 30% of the snakes examined were found in some sort of building structure. Roadways and trees composed 23 percent and 16 percent of the locations where snakes were caught.

A total of 105 snakes were measured which ranged from 16.5 cm to 243.8 cm. A mean length of 153.8 cm (S.D.=54.1, C.V.=35.2) was obtained which is similar to the average length for Boiga irregularis of 150 cm reported by McCoy (1980). General range of sizes are listed on Table 2.

Little current data on monitor lizard diets is available but Dryden (1965) reported monitors as having an eclectic diet. Birds and bird eggs were found by Dryden in only 3 (5.6%) out of 54 stomachs examined that contained food. Further study of monitor lizards needs to be conducted.

RECOMMENDATIONS

1. Continue to review literature on the monitor lizards and Philippine rat snakes.
2. Hire a biologist with expertise in herpetology to design and implement studies involving the life history, feeding ecology, abundance and distribution of both reptiles.
3. Consider implementing a bounty on both reptiles to obtain biological data and test the effectiveness of a possible predator control program.

LITERATURE CITED

- Drahos, Nick. 1977. Population dynamics of Guam birds. Unpublished manuscript.
- Dryden, G.L. 1965. The food and feeding habits of Varanus indicus on Guam. Micronesica 2:73-76.
- McCoy, M. 1980. Reptiles of the Solomon Islands. Sheek Wah Tong Limited, 80 p.
- Quitugua, Antonio. Director, Department of Agriculture, Government of Guam.
- Uchida, Teru Aki. 1966. Observations on the monitor lizard, Varanus indicus as a rat control agent on Ifaluk, Western Caroline Islands. Bull. Wld. Heth. Org. 35:976-980.

Report prepared by: Celestino F. Aguon

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-1

STUDY NO.: 1

JOB NO.: 3

JOB TITLE: Impact of Interspecific Competition Between Black Drongos and
Native Forest Birds.

PERIOD COVERED: September 30, 1981 to October 1, 1982

SUMMARY

Data compiled during a year-long study on drongo feeding habits were analyzed and conclusions were drawn on the possibility of interspecific competition for food resources. Results of the study were published as a master's thesis and will serve as part of a final report. Incidents of interspecific aggression for spatial resources continued to be recorded as they occurred.

BACKGROUND

A year-long study to determine the impact of possible interspecific competition between black drongos and native forest birds was implemented in August 1980. Literature on drongo life history, food preferences, and territoriality were reviewed and separate studies were conducted on drongo aggression and feeding habits. Three to five drongos were collected monthly in each of four major habitats on Guam. General biological data were obtained on each specimen and prey items from stomach contents were scored for size and identified to the lowest taxonomic level possible. Data on prey items, foraging techniques, foraging zones, foraging perches, and perch height were recorded during visual observations of drongos. Data were gathered in a similar manner for six primarily insectivorous native birds whenever encountered. During visual observations, instances of inter/intra-specific aggression were ranked for intensity and the species and age groups involved were recorded. Sixteen active drongo nests were also observed to determine if drongos were excluding native birds. Territorial behavior or evidence of nesting by native birds within a drongo's territory also were recorded. Incidental data on life history and general behavior of drongos also were collected for use in any future drongo control measures.

OBJECTIVES

To determine if significant interspecific competition for food or spatial resources occurs between the black drongo and Guam's native forest bird populations.

PROCEDURES

1. Data from the year-long study were analyzed to determine the pattern of drongo foraging habits and prey preferences.
 - a. A chi-square analysis was performed to test for significant differences among seven foraging techniques among four habitats and between wet and dry seasons.
 - b. A chi-square analysis was performed to test for significant differences among eight categories of foraging perches among four habitats.
 - c. A t-test was performed to test for significant differences between mean perch heights among four habitats.
 - d. Differences in the proportion of zones of concentrated foraging activity (defined by MacArthur [1958] as those zones which together comprise more than 50% of all observations for a particular perch height) were discussed for low, medium, and high perches.
 - e. A log-linear multiway analysis was performed on data from both stomach contents and visual observations. Standard residuals were used to detect significant differences in the proportions of prey items among months and among habitats.

RESULTS

1. Detailed results can be found in the thesis by Maben (1982). A summary of the conclusions derived from the above analyses is as follows:
 - a. Black drongos on Guam primarily are found in open field, disturbed second-growth forest, rural, and limestone forest habitats. Drongos appear to benefit from the presence of humans and seem to forage predominately in open areas surrounded by disturbed vegetation.
 - b. Drongos capture prey mainly by flycatching and dropping down on prey. Gleaning, flight-gleaning, and hovering are used more infrequently. Drongos forage rarely hang-gleaning or piracy.
 - c. Drongos primarily forage from perches located well outside any foliage. Categories of foraging perches on Guam include man-made objects, cattle, grasses, exotic shrubs and small trees, palms, ironwood, native shrubs and small trees, and tall native trees. Drongos commonly forage from man-made perches; the use of introduced or native plants and trees as perches varies according to habitat.

- d. Mean perch heights vary from 4.3 to 5.8 m and appear to be significantly higher in the limestone forest, which has an abundance of tall native trees and emergent snags.
 - e. Drongos appear to forage mainly in a downward direction within 0 - 3.3 m of a perch but the zones of concentrated foraging activity seem to vary according to perch height. Sallies from medium (3.4 - 7.6 m) and high (7.7 m) perches commonly result in flights of up to 6.0 m from the perch and often are directed upward. Sallies of greater than 12.1 m most often were made from high perches.
 - f. Drongos on Guam primarily are insectivores. Hymenopterans are the most frequently taken prey. In addition, spiders, orthopterans, beetles, and adult and larval lepidopterans regularly are taken throughout the year. Drongos irregularly forage on termites and bugs. Lizards including geckos, skinks, and American anoles are taken in small numbers. Drongos also will attack and eat small passerine birds, although only rarely.
 - g. Qualitative differences in foraging habits and food preferences suggest that competition for food between the black drongo and native forest birds is unlikely. However, serious quantitative research in this area needs to be conducted on the diets and foraging behavior of native avifauna before this question can be answered with certainty. Additional research into other possible causes for the decline to the point of near extinction of Guam's native birds needs to be conducted and appropriate measures implemented as soon as possible.
2. Data on inter/intra-specific aggression remains to be analyzed in detail although preliminary analyses created doubt that aggression by drongos is causing the decline of native bird populations. Certainly, drongos may be having a very localized impact on heavily attacked species such as the Mariana crow and the Micronesian kingfisher. Results from the aggression study are expected to be published as a technical report.

RECOMMENDATIONS

- 1. Continue to collect foraging data in a similar manner on Guam's primarily insectivorous species.
- 2. Continue to record instances of interspecific aggression involving drongos and native birds as they occur.
- 3. Complete data analysis of interspecific aggression and determine the impact drongos may be having on native bird populations.
- 4. Determine the need for possible drongo control measures.

LITERATURE CITED

- Maben, A.F. 1982. The feeding ecology of the black drongo Dicrurus macrocercus. M.S. thesis. Calif. State Univ. Long Beach, Long Beach, CA. 87pp.
- MacArthur, R.H. 1958. Population ecology of some warblers of Northeastern coniferous forests. Ecology 39:599-619.

Report prepared by Anne F. Maben

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-1

STUDY NO.: 1

JOB NO.: 6

JOB TITLE: Impact of Avian Disease on Guam's Native Bird Populations.

PERIOD COVERED: October 1, 1981 to September 30, 1982

SUMMARY

A study of the impact of avian disease on Guam's bird populations was implemented.

BACKGROUND AND JUSTIFICATION

Guam's native birds have declined drastically in recent years. With the exception of an occasional bittern and a small swiftlet population, none of the native land birds occur in the southern two-thirds of Guam, although all once occupied this area. Forest birds are now largely restricted to a strip of mature limestone forest on the far north of the island.

The avian decline on Guam is dramatically similar to the decline of Hawaii's native birds. Warner (1968) suggested that extinction of nearly half of the endemic Hawaiian land avifauna and restriction of the remainder to high mountain forests was due to the pathogenicity of avian malaria, pox, and other possible introduced diseases. On islands, such as Hawaii or Guam, where avian hosts may have lost resistance or never evolved resistance, the introduction of new pathogens or vectors may be devastating. Potential reservoirs for disease on Guam include migrant shorebirds and ducks, poultry, and several species of introduced birds.

An in-depth study of avian disease on Guam should provide insight into the cause of the avifauna decline. If disease is found to be a major decimating factor, mitigation steps can then be recommended.

OBJECTIVES

To design and implement an avian disease research program that will determine the presence and impact of disease on Guam's avifauna.

PROCEDURES

1. Preliminary review of literature, records, etc. on disease and potential vectors in the Mariana Islands.
2. Design and implement research program.
 - a. Collection and analysis of samples taken from migrant, native and introduced birds.
 - b. Sample vector populations on Guam.

RESULTS

The Department of Public Health and military agencies were consulted for results of their vector sampling programs. The number of mosquito species has increased from five collected in 1936 to a minimum of 25 (possibly as many as 35) species presently on Guam (McKenna, Chief, Env. Ent, USAF, pers. comm.; Nowell, 1975). At least three species are natural vectors of avian diseases. The prime vector in Hawaii (Culex quinquefasciatus) has been common on Guam since 1936, and possibly since 1911.

Tissue samples from three avian carcasses were examined by the National Wildlife Health Laboratory. A Rock Dove, an introduced species to Guam, had inclusion bodies suggestive of avian pox, intestinal coccidiosis, and mild acute portal hepatitis. The Golden Plover, a Guam migrant, also had inclusion bodies suggestive of avian pox and appeared to be reacting to an undetermined inflammatory disease. Both cases of pox were suggestive of an infection within an aberrant host. No significant findings were reported for the Chinese Least Bittern, the only native bird examined. Results are forthcoming for an additional 28 carcasses and 15 blood samples sent to the laboratory in July of 1982.

A new biologist has been hired whose primary responsibility will be to assess the impact of disease on Guam's avifauna, and a research proposal has been completed with input from the National Wildlife Health Laboratory.

RECOMMENDATION

1. Continue literature review and consultations with agencies regarding vector sampling programs in the Marianas. Initiate field sampling of vectors only if sufficient information is not available.
2. Continue sampling avian populations on Guam and initiate sampling on Rota and/or Saipan to ascertain disease activity unique to Guam.

LITERATURE CITED

- Nowell, W.R. 1975. International quarantine for control of mosquito-borne diseases on Guam. Proc. NATO-AGARD Aerospace Med. Panel Specialists meeting, Toronto, Canada.
- Warner, R.E. 1968. The role of introduced diseases in the extinction of the endemic Hawaiian avifauna. Condor 70(2): 101-120.

Report prepared by: Julie A. Savidge

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E -1

STUDY NO.: 2

JOB NO.: 1

JOB TITLE: Home Range and Activity Patterns of the Guam Rail (Rallus
owstoni)

PERIOD COVERED: October 1, 1981 to September 31, 1982

OBJECTIVES

To determine the home range and activity patterns of the Guam Rail.

RESULTS

This job was inactive during this segment.

RECOMMENDATIONS

This job should be discontinued and incorporated into Job W-5-3-3 of Project FW-2R.

Report prepared by: Robert D. Anderson

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E -1

STUDY NO.: 2

JOB NO.: 2

JOB TITLE: The Impact of Predation on the Guam Rail

PERIOD COVERED: October 1, 1981 to September 31, 1982

OBJECTIVES

To design and implement a program that will determine the impact of predation on the Guam rail population.

RESULTS

This job was inactive during this segment due to a shortage of staff. Related investigations were done under Job ES-1-1-2 and are reported there.

RECOMMENDATIONS

This job should be discontinued and incorporated with Job W-5-6-1 under Project FW-2R.

Report prepared by: Robert D. Anderson

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E -1
STUDY NO.: 2
JOB NO.: 3

JOB TITLE: Impact of Environmental Contaminants on the Guam Rail.

PERIOD COVERED: October 1, 1981 to September 30, 1982

SUMMARY

A study of the impact of environmental contaminants on Guam's bird populations was implemented.

OBJECTIVE

To determine the impact of pesticides, herbicides, and other environmental contaminants on Guam rail populations.

PROCEDURES

Because this Job was conducted in conjunction with Job ES-1-1-1, procedures were the same as reported for that Job.

RESULTS

Because of the similarities between this Job and Job ES-1-1-1, and the fact that they were conducted simultaneously, results are reported under that Job.

RECOMMENDATIONS

Base plans for further investigations of pesticide impacts on the Guam rail upon the results and recommendations of the final report to be issued under Job ES-1-1-1.

Report prepared by: Robert D. Anderson

GUAM WILDLIFE DEVELOPMENT
PROJECT W-4-D-1/W-4-D-2
Federal Aid in Wildlife Restoration Act

JOB PROGRESS REPORT
DEVELOPMENT PROJECT SEGMENT
FINAL REPORT

STATE: Territory of Guam

PROJECT NO.: W-4-D-1

W-4-D-2

SUB-PROJECT NO.: WD-2

SUB-PROJECT TITLE: Development of Office, Laboratory and Animal-Holding facilities.

PERIOD COVERED: October 1, 1982 through December 31, 1982

SUMMARY

Construction of a new office building and renovation of an existing laboratory building to provide laboratory, storage and animal-holding facilities has been completed.

BACKGROUND

The Division of Aquatic & Wildlife Resources has been housed in the same 1,463 sq. ft. office space since the Division was created in 1961. Since that time, the Division's programs and staff size have increased greatly to the point that office and laboratory space became limiting to efficient operation and precluded further development of the Division's programs.

In order to rectify the situation, a Wildlife Development Program was initiated in FY 1979 to construct a new office building and renovate an existing, unused laboratory building to provide needed laboratory, storage and animal-holding facilities.

OBJECTIVE

To provide adequate office and laboratory facilities to allow for necessary increases in staff and planned expansion of the Wildlife Section research program.

PROCEDURES

1. W-4D-1. Design and construct appropriately sized concrete office building at the Department of Agriculture near the present office of the Division of Aquatic and Wildlife Resources. The new office facility will be used by staff of the Wildlife Section.
2. W4-D-2. Renovate the former Soils Laboratory building at the Department of Agriculture to provide needed laboratory, storage and animal-holding facilities for the Division of Aquatic and Wildlife Resources.



New Wildlife Building



Fish and Wildlife Laboratory

RESULTS

Initially it was planned to construct a modular-type wooden building to provide office space, but because of recent changes in construction costs on Guam and upon the advice of the Department of Public Works, it was decided to construct a typhoon-proof, concrete building. Costs of concrete construction are not significantly higher and the building will have a much longer life and lower maintenance cost.

The office building was completed in April, 1982, and occupied by the Wildlife Section. The completed building is approximately 1,600 sq. ft. (32'x50') and includes a storeroom, wet lab, and restrooms. The new building is connected to the present administrative office building by a concrete walkway.

The laboratory renovation project was completed in November, 1982 and the facility is now in use by the Division staff. The completed facility is approximately 1,363 sq. ft. with an adjacent 759 sq. ft. covered work space. The original galvanized iron roof was replaced with a typhoon-proof concrete roof and all interior woodwork was replaced. The completed facility includes a storeroom, restroom, and two separate laboratory rooms.

Report prepared by Robert D. Anderson

Law Enforcement

LAW ENFORCEMENT

For the Fiscal Year 1982, there were three separate arrests made by the Conservation Officers in which hunters were charged with illegal possession of wild game that was hunted out of season. Two adult persons are involved in each case and all three cases are still pending.

Four separate arrests were made in which hunters were charged for hunting out of season and for illegally using an artificial light. Of these four cases one was dismissed because of insufficient evidence; one is pending; and the four suspects in the other two cases were convicted.

One arrest was also made in which an 18 year old person was charged with illegal fishing (fish poisoning). His 17 year old companion was released to the juvenile authorities. This case is still pending.

Additionally, we recorded several illegal fishing and hunting incidents which did not result in any arrests because the suspects were either warned or evaded apprehension. There were thirty-nine recorded incidents of illegal hunting; twelve recorded incidents of fish dynamiting; four recorded incidents of fish poisoning; two incidents of fishing with an electrical device; and five incidents of fishing in an off-limit area (Luminao Reef).

In summary, the number of arrests that were made for illegal hunting totaled seven in which fifteen adults were involved. Only one arrest was made for illegal fishing (poisoning) which involved one adult and one minor.

Thirty-nine illegal hunting incidents and twenty-three incidents of illegal fishing were recorded.

Report prepared by Charles R. Bonds

FY 82 ARREST FIGURES

	POSSESSION/GAME	PRIMA FACIE	DYNAMITING	POISONING
NO. OF SEPERATE CASES:	3	4	0	1
NO. OF CONVICTION:	0	2 (4 person)	0	0
NO. OF DISMISSAL:	0	1 (3 person)	0	0
NO. OF NO ACTION:	0	0	0	0
NO PENDING:	3	1	0	1
TOTAL NO. OF PERSON INVOLVED:	6	9	0	2

	NIGHT TIME HUNT (SPOTLIGHTING)	DAY TIME HUNT (GUNSHOTS)	POISONING	ELECTRIC DEVISE	OFF LIMITS
NO. OF INCIDENTS:	16	23	4	2	5

DYNAMITING

12

Special Programs
(Coastal Zone Management)

Fisheries Management and Development

The Guam Coastal Management Program provided funding through a Memorandum of Understanding to support a Program Coordinator III position within the Division of Aquatic and Wildlife Resources. The responsibilities of this position included providing staff assistance to the Chairman of the Guam Marine Fisheries Advisory Council (GMFAC), coordination of living marine resource development and management efforts among affected agencies, and coordination of the development and implementation of the Territory of Guam Fisheries Development and Management Plan.

The Territory of Guam Fisheries Development and Management Plan was completed during the report period and formally adopted by the Sixteenth Guam Legislature on April 13, 1982. Implementation efforts during the report period included:

- Development of draft legislation relative to promotion of local fisheries development.
- Development of draft legislation regarding quality control and truthful labeling of unprocessed imported seafood products.
- Analysis of the need for regulations for local sale of foreign caught scrap fish.
- Evaluation of insurance and loan programs available to Guam fishermen.

Efforts to improve on legal protection for the islands aquatic resources culminated with the enactment of Public Law 16-39, which amended the Government Code of Guam relative to the taking of fish and game to provide for:

- 1) Prohibition of the use of electrical shocking devices in the taking of fish;
- 2) Felony charges for the use of poisons and explosives in the harvesting of fish;
- 3) New restrictions on the use of gill nets.

Regulations for sport fishing in Masso reservoir were drafted and adopted during the report period.

The Program Coordinator also participated on the Cocos Lagoon Task Force, organized by the Department of Commerce to provide planning input for this area of southern Guam. Several Army Corps of Engineers permit applications, environmental assessments, and development plans were also reviewed and commented upon.

The printing and distribution of monthly tide charts continued to be coordinated with the Sea Grant Marine Advisory Program at the University of Guam.

Conservation Education

Guam has evolved from a subsistence economy to a monetary economy in a relatively short time. The improvement of hunting and fishing techniques coupled with the loss of taboos on unwise harvesting procedures has increased pressure on Guam's wildlife and aquatic resources. In addition there has been a decrease in many of Guam's native species. As a result the Guam Legislature passed a Guam Endangered Species Act (PL 15-36) and ratified a list giving 15 wildlife species endangered status.

In order to respond to a pressing need for materials and public involvement a public awareness/conservation education program was established in the Division of Aquatic and Wildlife Resources, through a grant from the Guam Coastal Management Program. A Public Information Officer (PIO) was employed to serve as a conservation education specialist to develop a program aimed at both school-aged children and the general public.

During this past year the PIO developed a second set of full color wildlife flyers and greater expanded the use of puppet shows and slide programs in the schools. Conservation education packets have been prepared and distributed to teachers. The increasing response from teachers for these presentations and materials is an indication of the program's success in filling gaps in the present curriculum. The PIO also conducted a highly successful National Wildlife Week Contest and public display at a major shopping center. The PIO also contracted with a local artist for 3 water color posters "Man, Land and Sea", "Familiar Fishes of Guam" and "Common Habitats of Guam".

A continuing media campaign utilizing press releases, radio and television announcements and feature articles to inform the public about aquatic and wildlife laws and endangered species has focused a great deal of local interest on these resources.

Workshops for military security personnel have helped alert those persons involved in protecting areas where most of the poaching occurs.

Since the inception of this program there has been increased interest and participation in resource protection by the public. There has been an increase in "tips" relating to illegal fishing and hunting and an increase in apprehensions, convictions, fines and penalties for violations. Another indication of the success of this program is in the noticeable increase in environmental awareness that has been reported by teachers and community leaders, and by requests from off-island groups and individuals requesting copies of our locally produced conservation education materials.

